AGRICULTURAL ENGINEERING

OCTOBER • 1952

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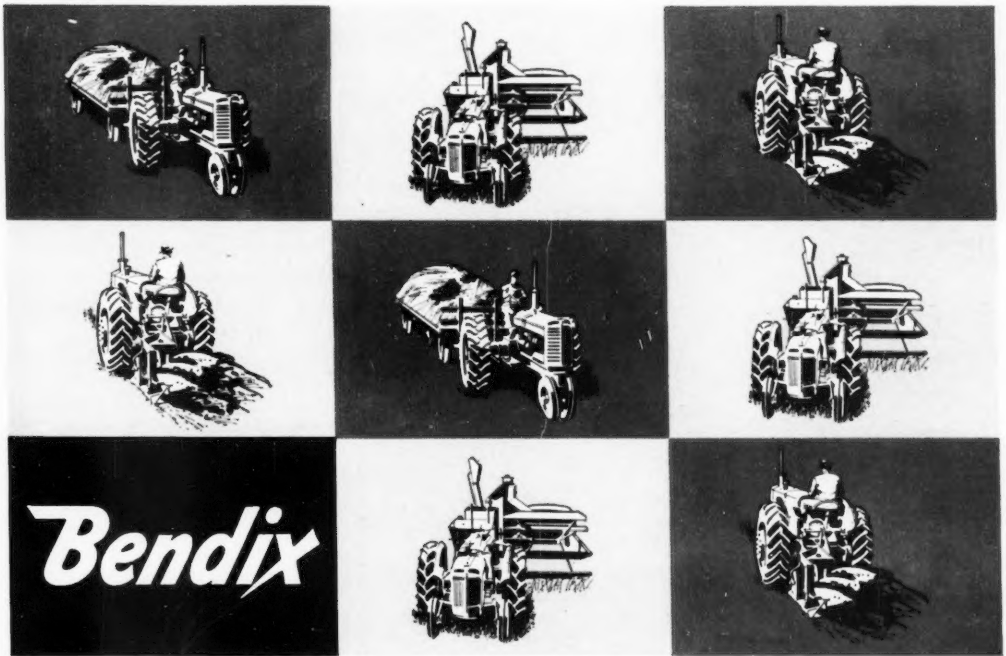
THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS



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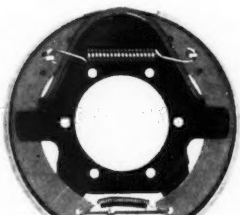

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AGRICULTURAL ENGINEERING

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Vol. 33, No. 10

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INDEX TO ADVERTISERS

TO OUR READERS: Advertisers in this issue present their products and services for your scrutiny, with confidence in their engineering merit and capacity to meet the requirements for which intended, and with confidence in your appreciation of these contributions to engineering progress in agriculture.

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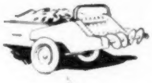

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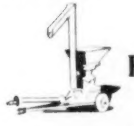

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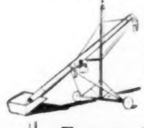

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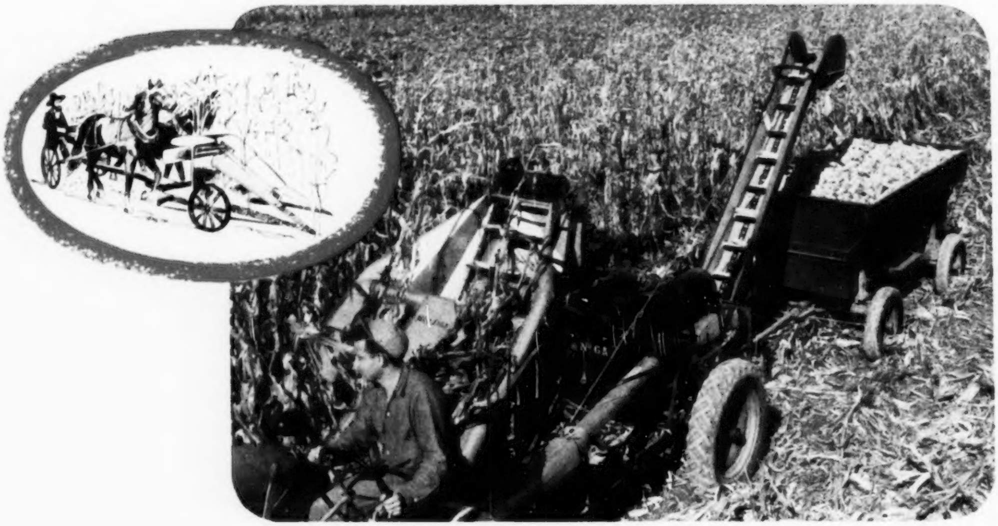

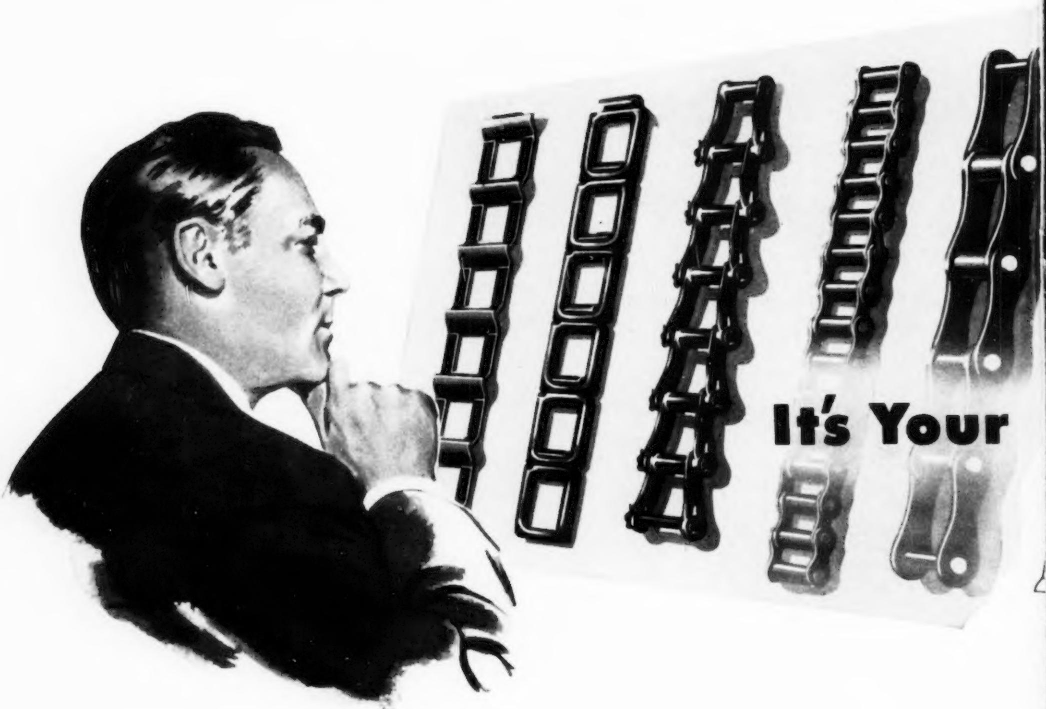

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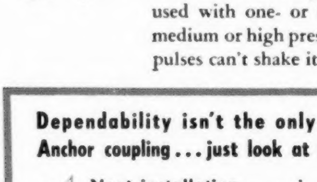

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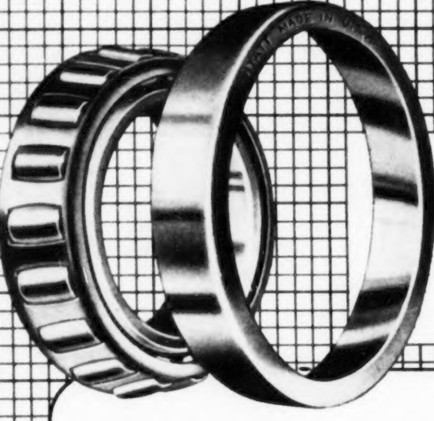

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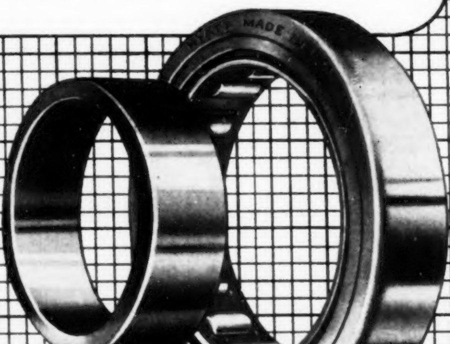

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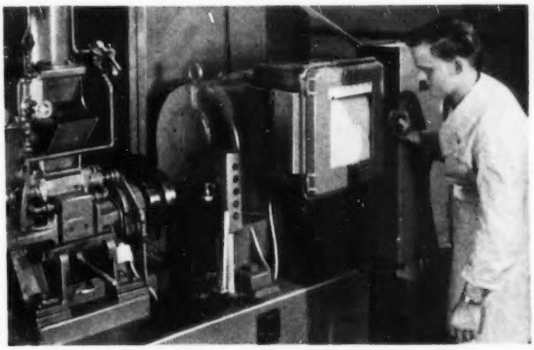

Does your problem involve research? Then rely on Dayton, makers of the *first* successful V-Belt, and pioneers in rubber research and development since 1905. For example, Dayton developed the process which made it possible to make rubber adhere to steel, and has led the way in developing oil-resistant and anti-freeze rubber. ©D.R.1952

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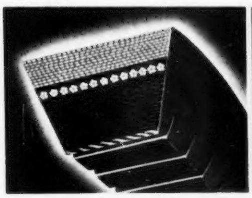
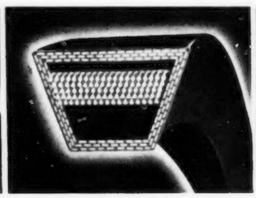


*Agricultural Cog-Belt**



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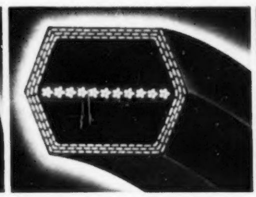

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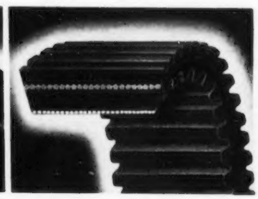

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*T.M.

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Since 1905

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You know, folks are inclined to think of our government in a lot of different ways . . . as a row of marble columns, or a towering dome of granite . . . as an array of silk hats and frock-tailed coats . . . as hour upon hour of stirring oratory, and sheaf upon sheaf of imposing documents.

But these things don't constitute government.

All these things are just the ornaments and the decorations, the gear and the raiment, the tools and the implements of the *real* government—the kind you see across the street.

No, the real government isn't hidden behind any marble columns or beneath any dome of granite. Instead, you'll find it in humble places like this . . . in schoolhouses, fire stations, general stores, garages, and vacant buildings all over the country . . . places set aside where people can vote on election day.

And rather than silk hats and frock-tailed coats, the traditional garb of government is the gingham of the housewife, the worsted of the accountant, the poplin of the mechanic, and the denim of the farmer.

Instead of stirring oratory and imposing documents, you'll find that real government boils down to just the brief words of identification, the pull of a lever or a simple mark on a ballot that indicates the free choice of the people.

That is government . . . American style. That is *government of the people, by the people, and for the people.*

And, as long as the people conscientiously carry out this great trust, we can be sure that "*this nation, under God, shall not perish from the earth.*"

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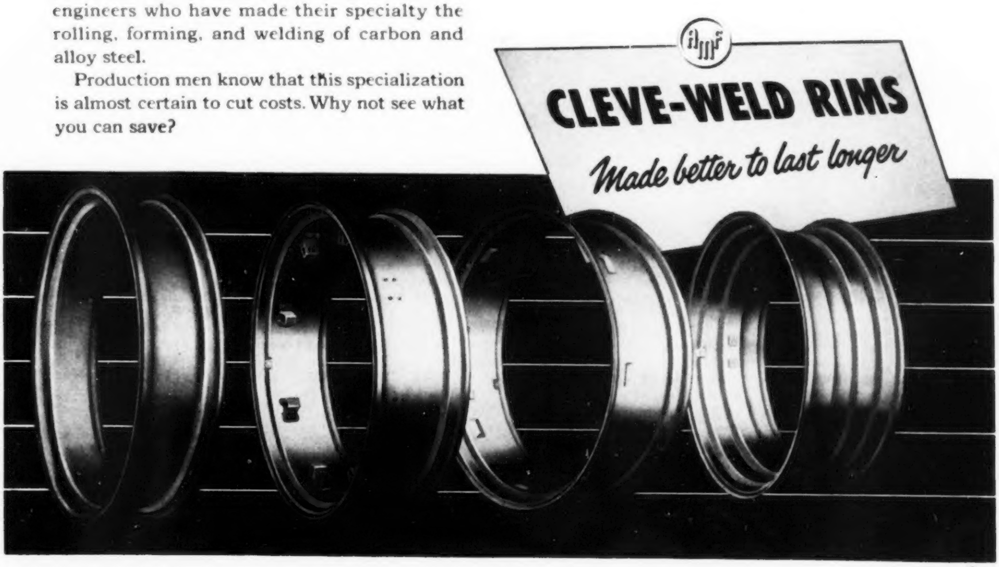

Invents Tree Puller

to save time and money in clearing land

Mr. W. E. (Bill) Stephens, co-inventor of the novel tree puller shown, backs into tree until fork points bite into trunk — he then pulls the hydraulic lift lever and . . .

Up comes tree and roots too, so that ground is ready for plowing. Co-inventor A. A. (Cotton) Zogg shows Texaco Driver T. I. Trahan length of root pulled from ground.

A tree-puller attachment for a tractor that yanks out young trees up to six inches in diameter at the rate of one a minute is the successful time- and labor-saving invention of A. A. Zogg and W. E. Stephens of Sheldon, Texas.

The big advantage of the tree puller over a bulldozer, according to the inventors, is that the tree puller brings up the roots too, so the ground is ready for immediate plowing. Bulldozers often leave the roots in the ground, it was said.

"A push and a lift does the trick," says Bill Stephens. "It's easy to keep our land free from young growth with our tree puller."

Like keen farmers and ranchers the country over, both Mr. Zogg and Mr. Stephens have found that *it pays to farm with Texaco Products.*

Because it exceeds Heavy Duty requirements, Havoline Motor Oil is ideal for trucks, Diesel or gasoline tractors and equipment using L-P gas as fuel. Naturally, there's nothing better for cars. Wear is practically eliminated. This has been proved by farmers like Fred Buscher (right) of Ritzville, Wash., who farms 780 acres. Texaco Man Paul Meyer pays a friendly service call.

There's no substitute for a lubricant that will stick to bearings — won't jar off, dry out or cake up. That's why so many farmers, like Martin Ball (left) near Battle Creek, Michigan, use Marfak — Texaco's famous lubricant for tractor, car, truck and farm machinery. Texaco Man Charles E. Gripe (right) has a word with Mr. Ball's daughter.

Friendly service, timely delivery and Fire-Chief, the gasoline with superior *"Fire-Power"* for low-cost operation, make a combination that farmers appreciate. Only Texaco Men can provide that combination in all 48 States. Texaco Man Clyde Mumper (left), of the Garber Oil Company, Mt. Joy, Penn., has just made a delivery to Mr. Maurice Nissley, Manheim, Penn.

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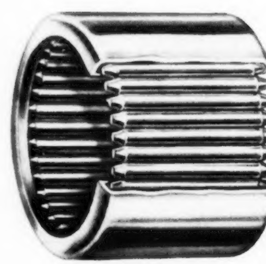

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EDITORIAL

Centennial in Retrospect

AN INTERNATIONAL congress of hermits might have drawn from their caves more individuals than stormed the doors at the recent Centennial of Engineering Convocation in Chicago. That, however, is a commentary on the nature of engineers, engineering and the public, rather than on the values derived from the Convocation.

As a mass meeting of individualists, the Centennial achieved about all that could be expected in the way of attendance. If engineers are not strictly individualists, many of them at least are relatively independent thinkers used to working alone or in small groups, and dealing with forces other than mass psychology. They may yet learn to master that force as well. The Convocation was a step in that direction.

As a public short-course in the appreciation of engineering, the Convocation was an outstanding success, we believe. It was well publicized by the daily press, radio, and television, as well as the more directly interested elements of the business press.

Word got around that engineers were taking a look at the ground they have covered, where they stand now, and where they are heading. Attention was invited to the fact that some of life's common material blessings, often taken for granted, have been made possible by the work of engineers.

Getting that one point across in some measure to a large section of the non-technical public was a major accomplishment. Smaller numbers of the public who take a sharper look at their worldly environment undoubtedly absorbed considerably more from the convocation and attendant news.

Some may have learned for the first time that there are many specialized branches of engineering, including an agricultural engineering branch which has something to do with the quantity, quality, and cost of their food supply.

As an occasion for self-appraisal within the profession, the meeting served a highly useful purpose. It induced some well-qualified men to take a backsight over the course of engineering progress during the past 100 years, to orient the profession in its present field of service, and to sight ahead along the route to desirable objectives for the future. It provided the opportunity to make their viewpoints a matter of record. It contributed and will continue to contribute to appreciation of their profession by young engineers. Demand for copies of the papers for use in engineering college seminars has already developed.

The very absence of many engineers who might have attended was a tribute to the urgency of their current work, and their devotion to that work.

A century of organized engineering has made man adequate to deal with many of nature's resources. There are indications that the second century, now beginning, may present many problems of making nature's resources adequate to the needs of man. Agricultural engineering will grow in importance as a line of approach to the solution of those problems.

Engineering for Advanced Agriculture

AMONG developments influencing training and knowledge requirements for agricultural engineers, E. G. McKibben* recently listed the following which are set down here as food for thought:

1 Rapidly extending use of new materials, metals, alloys, plastics, synthetic fibers.

2 Increasing importance to agriculture of thermodynamic and aerodynamic applications such as dehydration, air-conditioned storage, refrigeration and the possible general application of the heat pump.

3 Greatly increased use of chemicals in all three states (solid, liquid and gas) for insect, disease and weed control, for crop and animal responses, and for soil amendments.

4 Rapidly expanding use of electromagnetic energy and of electronic devices for instrumentation, for control units, for the possible processing of agricultural products, for insect and disease control, and for plant and animal responses.

5 Use of atomic radiations to study basic plant and animal life and growth processes.

6 Increasingly difficult problems of instrumentation as agricultural engineering becomes involved with variables more and more difficult to measure.

7 Increasing importance of experimental design and statistical methods as research becomes interested in smaller differences of more variable phenomena.

These are not all of the new developments which will influence the work to be done by agricultural engineers, but they suggest types of change and progress in the manner in which engineering may most effectively serve agriculture. They suggest new directions of application, new degrees of refinement, new areas for emphasis, new material and knowledge resources to be conserved and utilized through and for our human resources.

*An address on the effects of recent research on curriculum requirements in agricultural engineering presented before a meeting of the American Society for Engineering Education, at Hanover, N. H., June 26, 1952.

Professional Unity

ONE agricultural engineer has invited our attention to the fact that "the time is long past when the man who designs barns will be called upon to design field machinery." He might have included irrigation systems and electric brooders.

Wherein then is the essential professional unity among agricultural engineers?

Perhaps their strongest common bond is a unity of purpose in service to agriculture.

In the college agricultural engineering departments, and in some other places, there is a further unity of administration and daily association.

In technology there is the unity of basic training, viewpoint, method and interest in applications of physical science which distinguishes engineers from other professions. There are common interests in engineering materials, instruments, controls, research techniques and other matters.

There are also bonds of related subject-matter interest between any two branches of agricultural engineering, in such matters as sheds and shops for the storage and maintenance of mechanical equipment, mechanical equipment for use in and around buildings; structures for soil and water conservation and drainage for structures; stand-by power for generating electricity and electrically operated mechanical equipment; machinery to aid the practice of conservation and soil and water control measures planned to facilitate the operation of field machinery; wiring and lighting as basic factors in farm buildings and buildings planned to make the most of farm electrification; electric power for drainage and irrigation pumping.

There are also some agricultural engineering jobs which call for men well qualified for work in two or more branches of agricultural engineering. This is notably the case in those instances where a man may practice his agricultural engineering as owner, manager, or engineer of production and related operations in farming enterprises.

Some other types of work, particularly in industry, will encourage increasing specialization in one branch of agricultural engineering or another. Some men will show early inclination toward a high degree of technical specialization, and may make their greatest potential contributions to agricultural engineering progress through work of that nature. They can safely be encouraged and helped to qualify for effective work in one branch of agricultural engineering or another, so long as their specialization is based on a thorough appreciation of the common interest links holding agricultural engineers together as one distinct branch of the engineering profession devoted to serving agriculture.

AGRICULTURAL ENGINEERING

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The Engineering Revolution in Agriculture

By Ivan D. Wood
MEMBER ASAE
President, American Society of Agricultural Engineers

WHEN an engineer is asked to examine an object, animate or inanimate, a trend or even a philosophy, his first impulse is to measure it, if he can find suitable units by which to do it. To measure the "engineering revolution in agriculture," in commonly known units, is a difficult job. A revolution suggests a fundamental change from things as they were, and on this basis we can measure over-all changes and perhaps trace future trends, by means of the yardstick of the census. In making this examination it will be well to ask ourselves if certain measurements represent the real dimensions of this revolution or whether we are scanning a rainbow with only an imaginary pot of gold at its end.

IVAN D. WOOD

Since the object of our examination is so vast and has so many ramifications, we will confine our measurements to those phases which the hand of the agricultural engineer has helped to build. As we look at this colossus we see the work of many artisans, each assisting the other to produce the final result. Great progress has resulted where the engineer, the chemist, the agriculturist, and the physicist have combined their knowledge and skills first in research to find the facts and then in a wholehearted effort devoted to production.

Farm output per man-hour is certainly a unit of measure we can use. Today it is $2\frac{1}{2}$ times what it was 40 years ago, and 1.6 times greater than it was in the 1935-39 period. Since 1930 there has been a steady decline in the man-hours of work, yet the total farm output is now at an all-time high. We must conclude that the greater use of farm machines has been the chief influence in cutting the time used which in turn influenced the farm output per man-hour.

We might, for a moment, examine the horsepower available per agricultural worker today as compared to the past. In 1870 there was available to each agricultural worker 1.6 hp mostly in the form of horse flesh. Even as late as 1920 the figure was only 5.3 hp. In 1940 it had risen to 27.8 hp, and is now estimated at between 40 and 50 hp, depending on how much of the power of the farm automobile we wish to include.

This mechanization has been rapid everywhere, but nowhere has it been so spectacular as in the South and Southeast. In the states of Mississippi, Alabama, Georgia, North and South Carolina, Virginia, Florida and Tennessee, there has been a 325 per cent increase in the number of farm tractors in the ten-year period 1940-50. The number reported in these states in 1940 was about 73,000 while in 1950 it was over 300,000. Cotton culture once requiring 150 man-hours per acre with the man-mule system is now reduced to 18 hours or less with modern mechanization.

Everywhere in this development we see the hand of the agricultural engineer working with other artisans to develop the mechanical cotton picker while the chemist and the plant physiologist defoliate the plant so the machine will be working under better conditions. While the chemist develops new and potent weed killers, the agricultural engineer builds machines which will apply the spray properly. Thus the mechanization of the cotton-growing industry has grown from a humble beginning to where it bids fair to release 100,000 hand workers for other jobs.

We gain some idea of the importance of this mechanization process on the farm by noting the ten-year increase of the principal machines for agricultural purposes in the United States.

Since the tractor is the prime mover for most of the power equipment used on farms, let us examine it first. In 1910 there were probably not more than 1,000 farm tractors in use in the United States. As one manufacturer so aptly put it, "These machines 'had neither pride of ancestry nor hope of posterity'." By 1941, thirty years later, the number had grown to 1,675,000. By that time it was a thoroughly tried machine. The tractor had arrived on the American scene. By 1951 the number had reached the amazing total of 4,100,000.

Other machines have experienced similar growth proportions. In the ten-year period, 1941-51, the number of trucks in use on farms had increased $2\frac{1}{2}$ times, milking machines increased $3\frac{1}{4}$ times, combines 4 times and corn pickers almost 5 times. The great influence of these machines on farm practices and farm output could not be told in this short address. In passing, it might be noted that, according to best estimates, 40 per cent of all farm families do all their farm work without the aid of hired help.

Were time available, it would be possible to tell a story about each phase of this mechanization process. We shall tell a few of them, about some of the less known phases. Intriguing indeed is the story of weed control and how it is being accomplished.

It is conservatively estimated that weeds have cost the farmers of this nation about 5 billion dollars per year, or nearly 1,000 dollars per farm. One of the interesting developments of this century has been the battle between man and the vegetable world to keep weeds of the noxious variety from becoming the most serious threat to American agriculture. First came the potent weed killers, then the dusters, the sprayers, and the flame cultivators. Now more than 30 million acres of crops receive weed-killing treatment each year. The amount of 2,4 D alone used in one year amounts to more than 28 million pounds and the expense of this weed-killing venture is $40 million or more. In some communities 95 per cent of the farmers own all of their own weed-killing equipment.

An address before the agricultural engineers dinner arranged by the American Society of Agricultural Engineers in collaboration with the Society's Chicago Section and held in conjunction with the Centennial of Engineering celebration at Chicago, Ill., September, 1952.

The author: IVAN D. WOOD, collaborator between the Soil Conservation Service (research division) and the Extension Service, U.S. Department of Agriculture. Mr. Wood was the 1952 recipient of the John Deere Gold Medal awarded by ASAE.

Interesting stories could be told of the field ensilage harvester, the field hay baler and loader, and the green cutting of hay for dehydration. The romance of the reaper is a twice-told tale and very familiar to all. New agricultural machines appear each day and with the coming of each some process is improved, output per worker is boosted, or some task is made easier.

The airplane and the helicopter have arrived as implements for the agricultural industry. Special planes are being designed for dusting and spraying. Last summer, in one southern state, I saw what first appeared to be a busy airport in the country, but it proved to be only the headquarters of a cotton-dusting, flying circus. More than 5 million acres of crops are dusted and aerosoled in California each year and in Kansas more than 1 million acres are treated by this process each crop season.

The helicopter is being used in the Pacific Northwest for weed and brush killing on the banks of irrigation canals. One machine can treat 80 miles of canal per day, spraying a strip 20 feet wide on each side. The cost is about $5 per acre treated compared to many times that figure by usual methods.

In addition to being used for dusting and spraying, the airplane is used extensively for planting rice in some areas. Many western ranchers have discarded the saddle horse as too slow and now use a plane for inspecting pastures, directing haying operations in their far-flung meadows, finding fence breaks, hunting predatory animals, and flying to Chicago to look after their cattle shipments which started days before.

In 1950, 86 farms out of each 100 were using electricity from power lines. This shift from the hired hand to the "wired hand" is a spectacular phenomenon in agricultural history. The changes which it has made in farm living are well known to all of you. Man as a motor is not very effective. The little ¼-hp unit which may be carried under one arm is equal in effective work capacity to two men. Actually the electric motor might be called the "wired girl" since it relieves the housewife of the toil of carrying water, sweeping, ironing and mixing. It gives her refrigeration, clean electric cooking, cools the house and provides the whole family with good light to make leisure hours more profitable. The effect of this electric magic on the way of farm life can hardly be overestimated.

VAST EMPIRE BUILT BY SOIL AND WATER MANAGEMENT

If you will join me for a few moments in the jet plane of imagination, we will visit the vast empire which soil and water management has built. Water from mountain snows and vast underground reservoirs has transformed a desert into rich communities during this engineering revolution in agriculture.

Suppose, in our imaginary trip, we bring all the irrigated land to one place where we can view it and measure it. Below us we would see an area the size of Ohio, 25 million acres to be exact. We would see 132,000 miles of canals, enough to encircle the world 5½ times. Those marks on the ground surface would represent 15,000 miles of pipe lines which would stretch 5 times across the United States. We cannot see the water tunnels which puncture the mountain ranges, but there are enough to allow a traveler to go underground from Chicago to Indianapolis, Ind., a distance of 161 miles. Those marks across the rivers are a part of the 49,000 diversion dams and reservoirs. Those dots with the silver streamers running from them are the 116,000 pumped wells and 6,000 flowing wells which bring this irrigation lifeblood to the thirsty land.

Now we look into our guide book and note that this vast enterprise called "irrigation" represents a capital investment of billions of dollars, 2 billion dollars on the U.S. Bureau of Reclamation projects alone. It tells us that the gross crop returns from these Bureau projects were $542 million for the year 1950 and that the gross crop returns from these projects to date has been seven times the cost. All the returns have not come from agriculture. Power generated by the falling water returns about $36 million per year.

We ponder a moment and ask ourselves this question, "Does all this vast expenditure of money in irrigation works benefit only the West where most of it is located?" Our guidebook tells us of one Idaho project in which freight shipments increased from 2,200 cars per year in 1939 to 8,235 cars per year in 1949 with the coming of irrigation. We are surprised to note that 72 per cent of the $92 million value of this incoming freight was from states east of the Rocky Mountains. In all of the 17 western states where irrigation is the foundation of the most productive agriculture, retail trade amounts to more than $36 billion per year.

Looking below from our imaginary plane into the imaginary empire we note many orchards and vineyards. A look into our guidebook tells us that the enormous production of fruits and vegetables may actually have changed the eating habits of all our people. Here in this irrigation empire are grown virtually all of the nation's apricots, almonds, dates, figs, prunes and olives, 95 per cent of the grapes, 90 per cent of the lettuce, 85 per cent of the sweet cherries, 75 per cent of the avacados, pears and cantalopes, 65 per cent of the asparagus, 50 per cent of the peaches, and 50 per cent of the truck crops.

A look below now discloses an amazing phenomenon. The irrigated empire is growing before our very eyes. To the east is a bulge in the boundary line, and we ask the Bureau of the Census to explain. It seems that in the last ten years irrigation has not stayed put in the West but is spreading all over the map in one of the most surprising phases of this engineering revolution in agriculture. We look at the figures from three states only, for our time is short—Louisiana, Arkansas, and Florida. In these states we discover that the irrigated acreage has grown from 741,000 acres in 1939 to more than a million in a ten-year period. This is an increase of about 1,000 square miles, or an area about the size of Rhode Island. The engineer is largely responsible for this eastward movement of irrigation into humid regions. He made possible the sprinkler with light, easily portable pipe; he designed better pumping plants; he contrived spiles and siphon tubes and gated surface pipe and hose for better water distribution and found better water supplies by building farm ponds and high-yielding wells.

A DRAINAGE EMPIRE OF THREE MILLION ACRES

Now we seem to have passed the irrigated land but below us is another vast empire, four times the size of Ohio. Even from our great altitude, it stretches to the horizon. This land, too, is verdant with crops. We measure it with our census calipers and find that it contains 103 million acres and is called the "Drainage Empire." We find that it has grown from 65 million acres in 1920, to 87 million acres in 1940, and to 103 million in 1950. Land once water-logged through centuries with rainfall or spoiled by overirrigation or seepage is now in high production through the magic of drainage. This land also has thousands of miles of ditches and millions of feet of hidden draintile beneath the surface.

The hand of the agricultural engineer has helped also to shape the foundations of a vast undertaking in the conservation of our natural resources. He has helped to end the age when good land was exploited by wasteful and destructive methods in both dry and irrigation farming.

Conservation practices are being applied to the land and to our diminishing water supply through soil conservation districts the total number of which was 2,316 by the end of 1950. Conservation measures were applied to 25½ million acres in 1950 and this again is an area the size of Ohio. Conservation plans are in actual progress on an area of farm land equal in size to Texas and New Mexico combined, or 246,740,000 acres.

Truly there has been a revolution in the management of soil and water. Land surfaces are shaped in flat or sloping planes to aid in the distribution of irrigation water or facilitate drainage. In many areas the irrigation ditch is passing in favor of underground or surface pipe. Neatly lined ditches and canals prevent water loss and reduce the damage to lower lying lands from seepage. Hillsides once ravaged by erosion are terraced and contour-farmed and gullies are cured with structures and vegetation. Well-engineered sprinkler systems have brought the blessings of water to many areas where, because of soil and topographic conditions, surface methods could not be used.

While your imagination is in high gear, let us visit the grassland empire which is unfolding below us. Forty-five years

ago when the American Society of Agricultural Engineers was founded, an agricultural engineer would have had little interest in grassland about which we hear so much today. Grass in the form of hay or pasture covers about 60 per cent of the total land area of the United States. The area expands almost as we watch. New grasses are being introduced from other lands and old ones are being taught new habits.

It is true that the horse is passing, perhaps to oblivion, as a work animal. Though his numbers have shrunk from 25 million in 1920 to 10 million today, the acreage of hay stays about the same, 60 to 70 million acres. This hay is now transformed to meat and milk instead of furnishing motive power in the form of horseflesh.

Has the engineer had a hand in this great shift to a grassland agriculture? It was he who designed seeders which would handle the 5 million kernels of redtop seed per pound, or the 16,000 seeds of hairy vetch. He designed the various machines for renovating old pastures, clearing brush, plowing out roots and raking them into piles. On his drafting board came to being the tree dozer, the brush saw, the various machines for spraying noxious weeds and brush and the various devices for applying fertilizers. It is estimated that 200,000 acres of permanent pasture need renovation with the machines which now stand ready to do the job.

A fleeting picture of farm-building activity in the United States should include 7 million dwellings, 6 million barns and 20 million other permanent structures. The total investment is probably over $20 billion. These buildings must house 25 million milk cows, 60 million hogs, 31 million sheep, 480 million chickens in addition to calves, feeding cattle and other animals. They must provide storage for millions of bushels of grain, 50 million tons of hay, 40 million tons of ensilage as well as thousands of tons of fruits and vegetables.

Some significant changes have taken place in the engineering phases of the farm-building field which are worthy of attention. There has been a surge of new farm-house building and the remodeling of old ones. This remodeling phase has featured the installation of bathrooms, water systems, sewage disposal and electricity, modernizing of kitchens and the placing of insulating materials. The U.S. Extension Service reports assisting 54,000 families with the construction of new homes, 115,000 with remodeling old ones, 227,000 with remodeling of kitchens and 150,000 with installation of water systems all in 1951.

In the past ten years there has been special emphasis on labor saving with the installation of milking machines, conveyors for grain to the granary and to feed bunks, feed grinders, convenient water supply and electric lights. More attention is being given to paved feed lots which keep animals out of the mud and facilitate the heavy chore of manure hauling.

There has been a decided swing to the quonset-type building with the semicircular, self-supporting roof. Such buildings are used for grain storage, machine sheds, sheep barn, cow barn, garage and many other uses. It is not uncommon to find one such building serving some or all of these purposes at the same time.

The agricultural engineer has provided the know-how in the drying of corn, small grain and hay. This practice has resulted in the savings of millions of dollars of value which would have been lost through spoilage or downgrading from moisture. In some areas there has been a turn to cooperative track-side storage and even to cooperative milking barns. There has been organized an area-wide farm-building plan service which incorporates the findings of research fitted to the needs of the farmer. It is available to all at minimum cost. Utility and labor savings have become the watchword in the farm-building field.

Suppose we land our imaginary space ship in that green pasture beside those white buildings to have a look at the inside of the farm dwelling. If there has been a revolution in the engineering phases of agriculture, surely the farm home must have shared in its benefits.

As we look around we are amazed to see about all the conveniences and labor-saving devices to be found in a city home. In fact, we are told that in one Kansas community where a survey was made of families with electricity, 97 per cent had mechanical refrigeration, 87 per cent had electrical washing machines, 95 per cent had gas or electric stoves, 73 per cent had vacuum cleaners, 98 per cent had self-heating irons and 28 per cent had electric sewing machines. Latest figures for the country as a whole indicate that 61 per cent of farm homes have mechanical refrigeration, 47 per cent have

Typical of the engineering revolution in agriculture, so well delineated by ASAE President Ivan D. Wood in the accompanying text, are these pictures of John Deere agricultural machines illustrating how agricultural engineers have eliminated human drudgery and inefficient animal power in the mechanization of hay-crop production, from the standing grass in the field to a high-quality forage product in the haymow

either gas, liquid fuel or electric stoves, 95 per cent have radios and 5 per cent have television.

The mechanization of the farm unit which has brought about greater output per farm worker has, no doubt, affected population trends. Men turned to industry as farm machines reduced the need for hand work. In 1910, 32 million people, or 35 per cent of the total population, lived on the farms of this country. Farming was then a mode of life. By 1950, the farm population had shrunk to $24\frac{1}{3}$ millions, or 16 per cent of the total population. If present trends continue, only 10 per cent of our people will live on farms by 1975.

That farming has become an industry is evidenced by the growth in size of farm, the reduction in numbers and the heavy investment in mechanized equipment. Not long ago I visited an irrigated farm in Colorado on which the capital investment in motive power and equipment was $75,000. This is no longer even small business. Investments in equipment of $25,000 to $40,000 are common today.

The agricultural engineer and all others should be concerned with the growth of population in our own country and elsewhere in the world. In 1920 we were able to devote about 3.26 acres to grow food for each man, woman and child in the United States. Now we have 2.25 acres each on which we grow as much food as we did on the larger acreage. There is, however, a point of diminishing returns and many economists believe we have about reached that point. The harvested acreage of land does not change much now, but we add to the population at the rate of 2 million people per year. Every 20 seconds there is a new mouth to feed. For the world, the increase is about 70,000 per day, or 48 each minute. By improved strains of grain, by better use of fertilizers, by growing human food where we once grew horse feed, by irrigation, drainage and other means we have managed to stay well ahead in food production up to the present.

Sober Reflections on the Engineering Revolution in Agriculture

It is generally agreed that we must increase our food-producing capacity to care for 190 million people by 1975. Dr. Byron Shaw, administrator Agricultural Research Administration, USDA in testimony before the House Sub-Committee on Agricultural Appropriations said, in part: "This is a tremendous job that has to be done and most of it has to come through agricultural improvement. . . . You will recall that our achievement in the last 13 years was equivalent of 64 million acres of land. The job ahead requires the equivalent of 120 million acres." Irrigation of new land and reclamation of irrigated land now waterlogged can take up some of this slack, but we are working against a limited water supply. The pinch may not come in our time, but it is difficult to see how this country can escape the fate of other overcrowded nations unless we plan well for the future before it overtakes us.

Jacob Rosin in his new book, "Road to Abundance," tells us that agriculture as practiced today is too cumbersome; requires too much floor space. He thinks that much of the food of our future generations will be produced chemically. No doubt some of it will, but I fancy we will still have green fields of corn and wheat long after Rosin's book is forgotten.

Willard Price in a book, entitled the "Amazing Amazon," tells us of the great possibilities of food production in the now uninhabited tropics. The whole of the continent of Europe could be put easily into the watershed of the Amazon with room to spare. Mr. Price thinks here lies a great untapped reservoir for the production of food for the future.

We have now examined this "engineering revolution" in agriculture, and the time has come for sober reflection on its implications. I sometimes wonder if our complicated machines have far outstripped the ability of the human body to direct them. We should remember that the evolution of the body is a slow process. Through thousands of years we have been losing our little toe, but we still have it. We have, through millions of years, learned to walk and stand upright but our internal organs still revolt at the change from all fours.

Now we are asking this slow changing body to direct jet planes traveling at speeds which leave the sound wave trailing far behind them. Each long, holiday weekend four or five hundred people die trying to direct cars capable of 100 mph speeds. In head-on collisions human bodies become projectiles dashing themselves to death against windshields and instrument panels. Bottles and other seemingly harmless objects on the back window ledge also become projectiles which can crush skulls on sudden stops.

Farm accidents take an amazing toll of killed or maimed despite our safety programs. Machines with shafts, belts, gears traveling at speeds far greater than the old horse-driven equipment continue to take their toll.

Education and safety programs will help reduce casualties but something else is needed too. Automobile designers are beginning to think in terms of cars with safety harness which would save countless lives by holding the body in the seat. Front seats which will not rip out at any slight collision and trunks which have sheet iron partitions to hold the baggage and tools in place instead of allowing them to shear off the legs of helpless occupants, may become commonplace. Maybe our next great effort as engineers should be in the design of safety equipment which leaves very little to a human body which may be slow in adapting itself to this fast-moving world.

After we have examined this revolution in the engineering phases of agriculture and are amazed by what we are pleased to call progress, we might pause to ask ourselves this question: Has our sense of moral duty to our fellow man kept pace with this tremendous development we call progress? We have provided leisure time for almost all of our people. Are we using that leisure time for recreation, for self-improvement, for self-expression, and for the betterment of the less fortunate? I sometimes think that we must guard well that our labor-saving gadgets do not make us mentally and physically lazy. My grandfather could swing a sickle all day in harvesttime and spend most of the winter with a two-bitted axe clearing the farm for which he worked most of his lifetime. He could drive a ten-mule team with a jerk line, but I must have self-energizing brakes and hydraulic steering.

My father could make a set of harness, build a barn, shoe a horse or hew a log for a new house, but I must have windows which open and shut at the press of a button. I am not defending the old methods. I am very glad we do not have to use them, but let us not lose all of the spirit with which the pioneer met the obstacles of life. He had to work out his own salvation, save for the rainy day, and from these traits was born a hardy race of which we are forever proud.

Happiness and Freedom as Measurements of Achievement

I do not know that we have yet created a unit to measure achievement. Certainly recounting the number of tractors in use on farms or the horsepower available per agricultural worker is not the final answer. I have outlined the manner in which we have outsped all other nations in our productive processes, but surely this is not the final measure of progress. I suppose each one of you has an idea about the final goal of human existence and what constitutes it. To me it means happiness and freedom to live in this country as we have been privileged to do through the past years; to be able to give expression to any creative urge that we may have in art, music, literature or mechanics; to know that our children may live in freedom and have an equal opportunity with all others.

We must conclude that the machines we have built and processes we have evolved, provide one element which makes for happiness. They have removed the drudgery from farm life and have given us leisure time for recreation and creative expression, for learning and for enjoying the companionship of friends and loved ones.

I have experienced the dead fatigue which comes from following a walking cultivator all day in the heat of summer and of doing chores far into the night. I have seen my mother washing dishes long after the men's work was done. This was always a six-day routine, and sometimes seven if necessity demanded. There was little time for reading, little time for recreation, little time to build those things which one's imagination often builds in the mind's eye.

We have removed the drudgery from farm life. We have started the conservation measures *(Continued on page 626)*

Design of a Plate-Type Heat Exchanger

By Henry Giese and T. E. Bond
FELLOW ASAE ASSOCIATE MEMBER ASAE

ADEQUATE and proper ventilation in farm animal shelters has been a continuing problem in areas of low winter temperatures. The maintenance of high animal health and productivity, the provision of a compatible environment for those who must care for the animals, and the prevention of deleterious condensation should all be realized in a structure with a properly planned ventilating system. Animal-shelter ventilation is primarily a matter of moisture removal which, in turn, dictates a minimum supply of ventilating air. During periods of low temperature, the animal heat alone is often insufficient to vaporize moisture from animals, to offset heat losses through building walls and to warm the required supply of ventilating air. This paper describes a plate-type heat exchanger that can be used as an element of a forced-draft ventilation system and will provide a source of supplemental heat in utilizing the otherwise wasted heat energy of the exhaust air.

PREVIOUS HEAT EXCHANGER INSTALLATIONS

Tests of heat exchangers installed as the result of previous investigations at the Iowa State College indicate that this method may provide the solution to many of the ventilation problems in animal shelters.

Ibrahim (5)* installed an exchanger in a 20 x 24-ft poultry house. The exchanger used consisted of an 8-in square duct, 20 ft long, enclosing four 3-in galvanized steel pipes. The warm exhaust air moved through the pipes in a counterflow direction to the cold fresh air moving in the annular space. The installation proved very effective and maintained desirable environmental conditions except in periods of extreme low temperatures.

Ibrahim (4) also installed an exchanger in a dairy barn that had a 10-ft ceiling, low animal population, and poorly insulated walls. The resulting conditions in this barn were superior to those in a nearby barn of higher quality construction and greater animal population. The exchanger used was 30 ft long with sixteen 3-in pipes surrounded by a 16-in square duct.

Downing (2, 3) used an exchanger consisting of two rows of 4-in pipes, 4 pipes in a row. The pipes were on 5-in centers and were enclosed in an 11 x 21-in duct, 45 ft long. Parallel flow was used with the incoming air passing through the small pipes and the exhaust air flowing through the annular space surrounding them.

It was shown from these studies that by using a heat exchanger it was possible to ventilate barns at full ventilation rate with outside air temperatures from 16 to 19 F lower than when ventilated by some means in which the incoming air was untempered.

Several units manufactured by the Louden Machinery Company and installed in cooperation with the Public Service Company of Northern Illinois have proven eminently satisfactory.

AIR-VOLUME REQUIREMENTS FOR VENTILATION

Animal shelter temperatures of 40 to 60 F are generally considered to constitute a range conducive to good health and high productivity of most farm animals. When outside air temperatures fall below this range, the animal heat source is usually relied upon to maintain the inside building tempera-

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*Numbers in parentheses refer to the appended references.

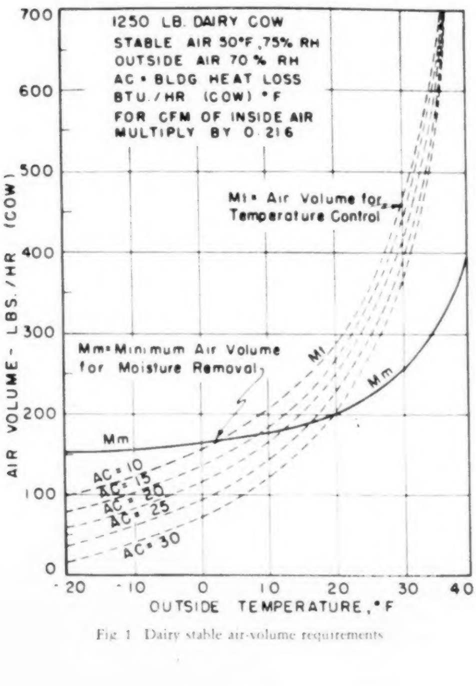

Fig. 1 Dairy stable air-volume requirements

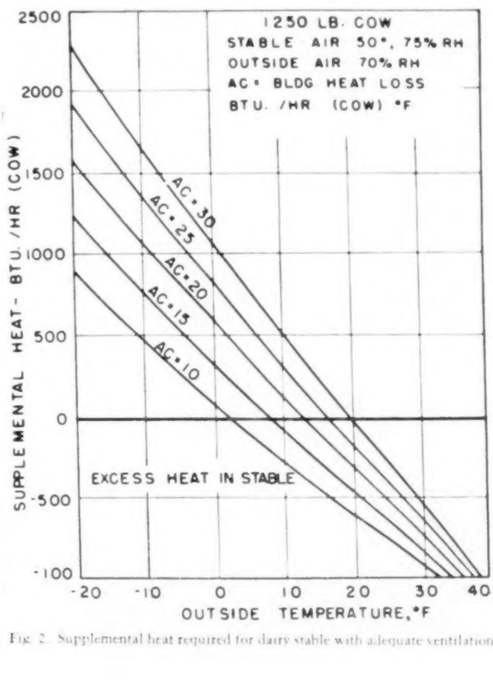

Fig. 2 Supplemental heat required for dairy stable with adequate ventilation

ture. The air volume requirement for proper ventilation depends essentially upon a volume of air sufficient for complete moisture removal and compatible with the maintenance of the desired animal shelter temperature. Under conditions of low outside temperatures, the amount of ventilating air may be limited by a minimum for moisture removal and a maximum which will maintain the desired building temperature. The optimum volume of air will be that which will satisfy both of these conditions. These air volume requirements are shown in Figs. 1, 3, and 5 for a dairy stable, a poultry house, and a hog farrowing house, respectively. The supplemental heat required in each of these buildings, if proper ventilation is supplied, is shown in Figs. 2, 4, and 6.

The dairy stable curves, Figs. 1 and 2, were developed from animal heat and moisture loss data of Kibler and Brody (6) and Thompson and associates (11). The curves of Figs. 3 and 4 were developed from the data of Mitchell and Kelley (8), and the curves of Figs. 5 and 6 from Mitchell and Kelley (9).

HEAT-EXCHANGER DESIGN

The greatest obstacle to the use of heat exchangers in animal shelters is the ordinarily low temperature differential existing between the warm (exhaust air) and the cold (incoming air) fluids in the exchanger. The required heat transfer must be accomplished by a large heat transfer surface or a very high fluid velocity in the exchanger. Since the fluid velocity affects the operational cost in overcoming fluid friction, an exchanger with a large surface area would seem to be the most economical.

A practical heat exchanger should incorporate large heat transfer surface, low operating cost, low first cost, ease of fabrication, ease of operation, and small space requirement. A plate-type exchanger appeared to offer the possibility of providing a desirable combination of these features. This type of exchanger, consisting of a number of highly conductive plates separating the two fluids, is widely used in industry. The number of plates, and the spacings between each, can be varied to change the performance characteristics so that a basic unit can readily be changed to meet varying requirements of several different animal shelters.

For a plate-type exchanger, it was felt that sheets of corrugated aluminum roofing serving as the plates, or fluid separators, would provide excellent heat-transfer surfaces. These light, relatively inexpensive sheets have excellent thermal conductivity and should provide many of the desirable features suggested.

For an initial design, 32 standard corrugated aluminum roofing sheets, 26 x 72 in, were stacked to form the fluid flow sections (Fig. 7). One-fourth-inch spacers were placed between them and the opposite edges fastened. This formed an accordian-like unit with alternate flow sections through the stack for the warm and cold fluids. The entire stack was enclosed with sheet metal, and provided with entrances and exits for the warm and cold fluids to form a basic plate-type heat-exchanger unit. The assumed size provided a heat-transfer surface of approximately 370 sq ft and a cross-sectional area for fluid flow of approximately 0.70 sq ft, which were similar to those used by Downing (2, 3) and Ibrahim (3, 5).

Theoretical Heat-Transfer Coefficients. The maximum performance requirements considered for the exchanger installed in an 18-cow dairy barn of average construction would be encountered when the outside temperature was −20 F and the inside temperature was to be maintained at 50 F. For these conditions the air volume required, Fig. 1, is 150 lb per hr per cow, and, from Fig. 2, the additional heat that the exchanger must supply is 1586 Btu per hr per cow. Since the fluids will act essentially as gases, flowing parallel to plane surfaces, Brown and Marco (8) suggest the following equation for finding the local heat-transfer coefficient:

$$h = 0.055\, k/L\, (LG/\mu)^{0.75} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

where $L = 2$ for any surface length over 2 ft

h = local heat transfer coefficient on either side of separating wall, Btu per hr per sq ft per deg F

k = coefficient of thermal conductivity of fluid, Btu per hr per sq ft per deg F per ft

G = mass velocity per unit flow area, lb per hr per sq ft

μ = absolute viscosity of fluid, lb per hr per ft

Then $h = 3.66$ Btu per hr per sq ft per deg F.

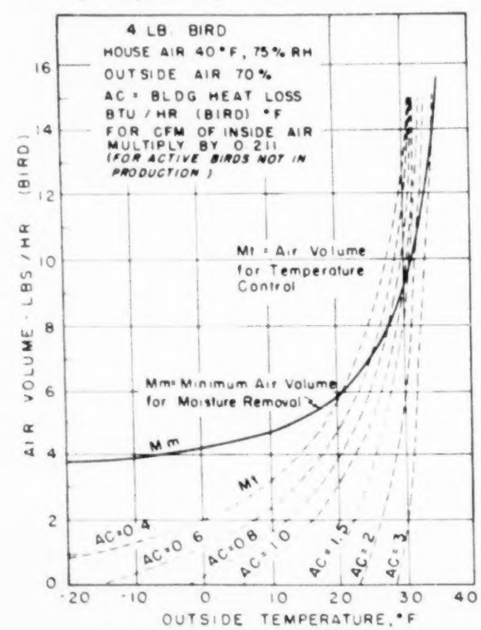

Fig. 3 Poultry house air volume requirements

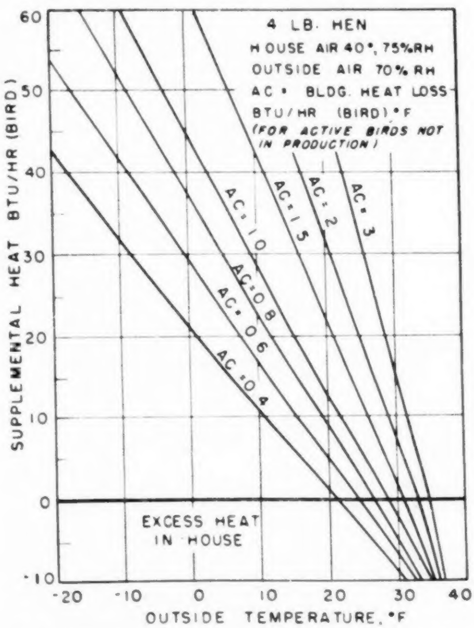

Fig. 4 Supplemental heat required for poultry house with adequate ventilation

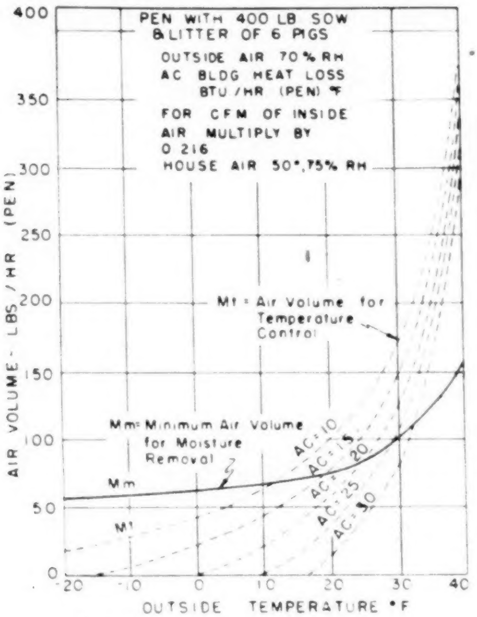

Fig. 5 Farrowing house air-volume requirements

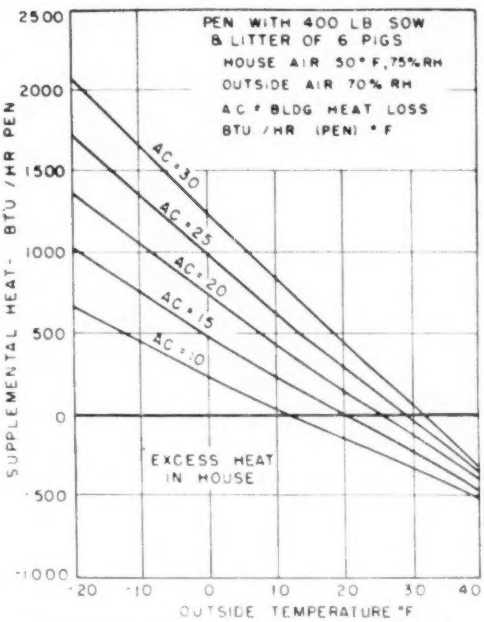

Fig. 6 Supplemental heat required for hog farrowing house with adequate ventilation

In any heat exchanger the following general relationships are assumed to hold, providing the heat-transfer coefficient, U, the constant pressure specific heat, C, and the fluid rates are all constant:

$$Q = CcWc\ (tc2 - tc1) = ChWh\ (th1 - th2) \qquad [2]$$

$$Q = UA\theta_{1m} \qquad [3]$$

where Q = heat transfer rate, Btu per hr

A = heat exchange surface, sq ft

$th1$ and $th2$ = initial and final temperatures of fluid being cooled

$tc1$ and $tc2$ = initial and final temperatures of fluid being heated

C = constant-pressure specific heat of fluid

W = fluid rate, lb per hr

over-all heat transfer coefficient, Btu per hr

U = per sq ft per deg F

$\theta 1m$ = logarithmic mean temperature difference.

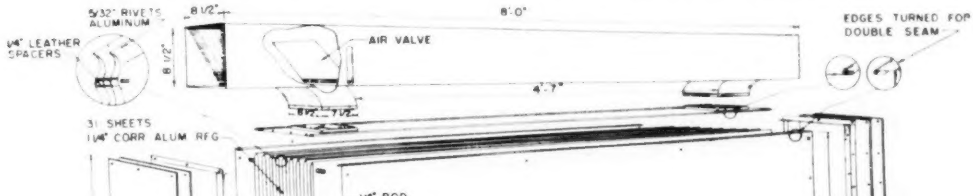

Fig. 7 Plate-type heat exchanger

Since, in the present case, the local coefficient of heat transfer, h, for the warm and the cold side of the plates will be approximately the same,

$$1/U = 2/h, \text{ or } U = 1.83 \text{ Btu per hr per sq ft per deg F}$$

The mean temperature difference between the fluids is not known, but Fig. 8 can be used to find the heat that would be gained from the exchanger under the conditions assumed. Since $UA/CW = 1.08$, and $ChWh/CcWc = 1$, then from Fig. 8

$$(tc2 - tc1)/(th1 - tc1) = 0.518$$

and $tc2 = 16.26$ F; $Q = 23{,}500$ Btu per hr.

It was found from Fig. 2 that 1586 Btu per hr per cow, or 28,500 Btu per hr, would be required. This is higher than the 23,500 Btu per hr obtained from the exchanger, but previous heat exchanger installations have shown that actual values of U may be expected to be 20 to 50 per cent greater than theoretical values, hence the actual heat gain should be greater than that indicated.

Power Loss in Exchanger. On the basis of the calculated heat gain from the exchanger, the assumed design would theoretically meet the requirements. However, the pressure drop through the exchanger, or the power loss, is

TABLE 1. EFFECT OF PLATE SPACING ON EXCHANGER PERFORMANCE

(Assumed: A [illegible]-plate (26 x 72 in) unit in an 18-cow barn maintained at 50 F. Outside temperature is -20 F, air flow [illegible] lb/hr, and additional heat required is 28,500 Btu/hr.)

Plate spacing, in.	Heat transfer coefficient U, Btu/hr/sq ft/deg F	Heat gain from exchanger, Btu/hr	Pressure loss		Heat transfer efficiency, per cent
			in H_2O	hp	
1/4	1.83	23,500	1.82	0.159	52
3/8	[illegible]	20,800	0.55	0.042	46
1/2	1.59	17,700	0.23	0.019	39

indicative of the power requirements for the exchanger and should be considered in the design.

To calculate the expected power loss through the unit, McAdams (7) suggests a form of the Fanning equation using an equivalent diameter equal to four times the hydraulic radius for turbulent flow in rectangular ducts:

$$P = \frac{0.096\, f\, L\, V^2\, \rho}{g\, r_h} \qquad [4]$$

where P = power loss, inches water
f = friction factor
L = duct length, feet
V = fluid velocity, feet per second
ρ = fluid density, pounds per cubic foot
r_h = hydraulic radius, feet

Then $P = 1.82$ inches of water.

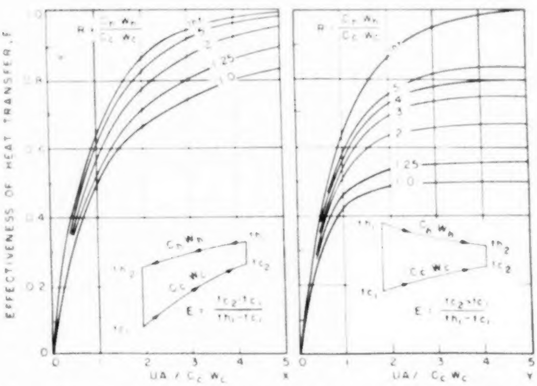

Fig. 8 (*Left*) Counter flow heat-exchanger performance • (*Right*) Parallel flow heat-exchanger performance

Table 1 shows the expected performance of the proposed exchanger using different plate spacings.

The foregoing calculations indicate the unit could be applied satisfactorily in an 18-cow barn. The efficiency could be improved by increasing the heat-transfer area, but Fig. 8 shows that to increase the efficiency from 52 to 75 per cent would require doubling the area. Improvement could also be made by increasing the over-all coefficient of heat transfer U, but this would result in an increase in power requirement. The efficiency of 52 per cent for the 1/4-in spacing evidently approaches the upper limit of economic feasibility.

FABRICATION AND TEST

On the basis of the performance determination from the above calculations, a basic heat-exchanger unit, Fig. 7, was constructed as described under "Heat Exchanger Design." The over-all size was 10 x 26 x 72 in. In Fig. 9 an end view of the exchanger is shown with end plate removed. Sheet-metal ducts were added along each edge of the unit to conduct air from the exhaust and fresh air fans to the exchanger. Air valves were placed in each duct so the desired amount of air could be forced through the exchanger. These ducts are shown in the laboratory test arrangement, Fig. 10.

The exchanger was tested in the laboratory with the laboratory air serving as the exhaust air through the exchanger. This air was first passed through a humidity chamber so that it would more nearly represent the humid air usually found in animal shelters during the winter. The fresh air was brought through the top duct shown in Fig. 10 and exhausted into the laboratory after it passed through the exchanger. Identical 12-in forward-curve double-inlet blowers were used to force the cold fresh air and the warm laboratory air through the exchanger. One-half-horsepower motors were used on each.

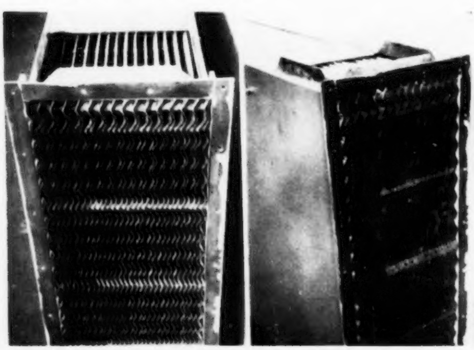

Fig. 9 End views of exchanger with end plate removed

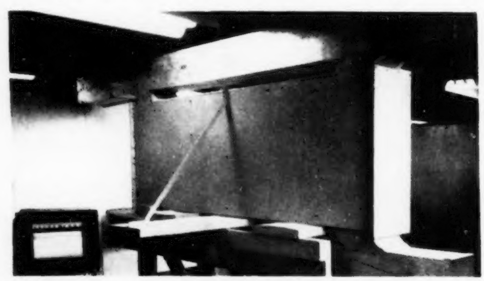

Fig. 10 Laboratory test arrangement for plate-type heat exchanger

Air volumes and temperatures were varied and the wet and the dry-bulb temperature of both airs were determined as they entered and left the exchanger.

TEST RESULTS

The efficiency of heat exchange is perhaps the best indication of performance for an exchanger but does not tell the complete story. The efficiency of heat transfer, or better, the effectiveness, of the exchanger is the ratio of the temperature rise of the fresh air to the maximum possible rise, where the maximum possible rise is the difference between entering exhaust and entering fresh air. This was shown by Perry (10), for a counter-flow exchanger, as

TABLE 2. SYSTEM CHARACTERISTICS

Fan speed, rpm	Static pressure, in H2O	Air volume, cfm	Fan horsepower	Heat exchange per deg F temp. diff., Btu/hr/deg F
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
728	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

$$E = \frac{t_{ce} - t_{ci}}{t_{hi} - t_{ci}} = \frac{1 - e^{-\left(1-\frac{1}{R}\right)\frac{UA}{CW}}}{1 - \frac{e}{R}^{-\left(1-\frac{1}{R}\right)\frac{UA}{CW}}} \quad [5]$$

Values of effectiveness for the exchanger during the tests ranged from 50 to 70 per cent, depending upon the ratio, R, of the volume of exhaust air to the volume of fresh air, and upon the amount of condensation within the exchanger.

The effectiveness of an exchanger can be increased by increasing the area, but the power required also increases. For this reason, an effectiveness of heat exchange greater than 70 per cent probably indicates an undesirable balance between first cost, power required, and heat recovery.

The coefficients of heat transfer are directly indicative of the amount of heat transfer that can be expected. The actual values for the over-all coefficient of heat transfer, U_{ex}, were determined from the experimental data and compared with the theoretical values, U_{the}, obtained from equation 1. Values for U_{ex} were obtained from equation 3. Local coefficients of heat transfer h_c were obtained for those points for which the volumes of fresh and exhaust air through the exchanger were equal so that $h_c = 2U$. These experimental values for h_c were plotted against air volume, Fig. 11, and a regression analysis provided the following equation:

TABLE 3. DAIRY-BARN HEAT BALANCE WITH EXCHANGER

(30-cow barn maintained at [illegible] F)

[illegible] lb air per hour supplied by exchanger
[illegible] lb air per hour supplied through infiltration
[illegible] lb air per hour supplied by auxiliary fan

Outside temp., deg F	Heat from exchanger, Btu/hr	Heat from cows, Btu/hr	Bldg. heat loss, Btu/hr	Vent. heat loss, Btu/hr	Heat gain to bldg., Btu/hr	Total air flow, lb/hr
-20	[illegible]	42000	25200	[illegible]	-7725	3300
-10	[illegible]	42000	21600	47500	[illegible]	3300
[illegible]	22125	42000	18000	39600	6125	3300
10	17700	42000	14400	31600	14700	3300
[illegible]	1327[illegible]	42000	10800	32400	12075	4500
[illegible]	[illegible]	42000	7200	21600	20000	4500

$$h_c = 2.284 \times 10^{-3} \, (W/c\mu)^{0.657} \quad [6]$$

The values of h_c, for the points where the air was not humidified, lie very close to the theoretical curve. Although there are only a few points plotted, they indicate the probable validity of the theoretical equation as applied to the present exchanger even though the curve is from data for parallel flat plates. A comparison of the two curves indicates the effect of increased humidity of the exhaust air. The high humidity of around 80 per cent, normally encountered in dairy barns in the winter, provides an increase in heat transfer for the exchanger.

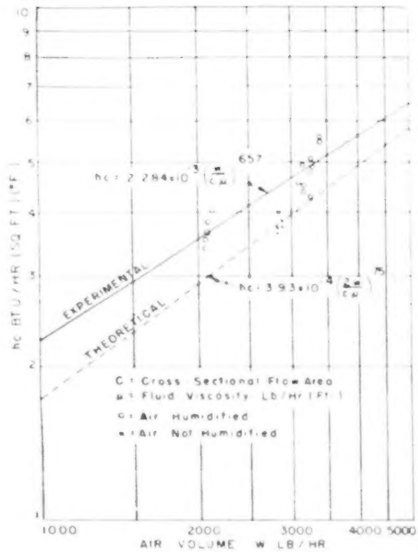

Fig. 11 Local heat transfer coefficients

The characteristics of the exchanger unit are shown in Table 2. Since the fresh air and the exhaust air side of the exchanger are essentially identical, the characteristics shown in the table are for either the warm or cold side.

The static pressure of the system varies very nearly as the square of the capacity. In an actual installation in an animal shelter, there would be an additional friction loss depending on the amount and size of pipe used in the distributing system.

The terminal temperature differences in the exchanger are very nearly equal so that the arithmetic mean temperature difference, θ_a, can be used in place of the logarithmic mean temperature difference, θ_{lm}, between the fluids. The arithmetic mean can then be used in design and application considerations for this type of exchanger, greatly simplifying the calculations.

DESIGN PROCEDURE

The following example is given to show the procedure for determining the number and size of plates to use in designing a plate-type heat exchanger for an animal shelter, or for analyzing the expected performance of a particular design.

Problem: Determine the area, or the number of plates required for a plate-type heat exchanger to be used in ventilating a 300-bird poultry house with a building heat loss value of $AC = 1.0$. Assume 4-lb birds. Design for maximum condition of −20 F outside temperature with the inside to be maintained at 40 F.

1 Find air flow and supplemental heat required from Figs. 3 and 4. For 300, 4-lb birds and −20 F outside temperature, air volume required = 3.75 x 300 = 1125 lb per hr. Supplemental heat required = 78 x 300 = 23,400 Btu per hr.

2 From $Q = UA\theta_a$, $UA = 23{,}400/30 = 780$. With ¼ in spacing between sheets, fluid flow area c = number of sheets ÷ 48.

3 Assume 30 sheets. $c = 0.625$ sq in; $W/c = 1125/0.625 = 1800$. From equation 6 or Fig. 11, $h_c = 2.47$; $U = 1.24$. Then $A = 780/1.24 = 628$ sq ft. If 30 sheets are used, 10-ft lengths would be used to give a total of 600 sq ft.

If, in the above example, 40 sheets had been assumed, the results would show that essentially the same heat could be obtained with 40 (10-ft) sheets as with 30. The same calculation assuming 40 sheets would show that a total of 760 sq ft would be required, in which case 10-ft lengths would be used. Since ¼-in spacing was assumed in both cases, the difference is

in the smaller cross-sectional area for fluid flow in the case of 30 sheets. For the same amount of air this results in higher fluid velocities through the exchanger and, consequently, a higher coefficient of heat transfer. For large volumes of air the greater number of sheets would be recommended in order to minimize the power requirements. However, in the above example, with such a low air-volume requirement and, consequently, a small power requirement, the use of the 30 sheets, rather than 40 sheets, is recommended.

APPLICATION

There are several ways in which the exchanger could be applied in an animal shelter, depending upon the temperatures to be maintained, and upon the size and number of sheets used in the design. For a theoretical application, consider the 31-plate unit that was tested. This might be applied in an animal shelter as an auxiliary source of heat, using a constant flow of air through the exchanger and supplying any additional ventilation by an auxiliary fan. Say the air in an 18-cow dairy barn, with a building heat loss $AC = 20$, is to be maintained at 50 F and 75 per cent relative humidity. Assuming that there is an infiltration of 200 lb per hr of air through cracks, this, together with a constant supply through the exchanger of 3100 lb per hr, would furnish the required ventilating air to 20 F outside temperature. At 20 F a small auxiliary fan would supply an additional 1200 lb per hr to furnish enough ventilating air for moisture removal. A heat balance for this barn for the conditions imposed (Table 3) shows that an inside temperature of 50 F could be maintained until the outside temperature fell below −8.2 F. (Without the exchanger it could be maintained only above 12.7 F outside temperature.) Even when the outside temperature dropped to −20 F, the inside would still be above freezing at 38.2 F. Without the exchanger the temperature would fall to 17.3 F.

This barn would be provided with ample ventilation up to 32 F outside temperature above which the exchanger would no longer be needed as a heat source and a greater amount of ventilating air could be obtained by closing the valves and by-passing the exchanger.

Since Fig. 2 indicates that no additional heat is required when the outside temperature is above 20 F, perhaps it would be better to use a constant supply of 3300 lb per hr of air through the exchanger which, together with the 200 lb per hr that is infiltrating, would furnish the required ventilation at 20 F, eliminating the need for an auxiliary fan. Above 20 F additional ventilation could be obtained by by-passing the exchanger. Operating this way, a 50 F inside temperature could be maintained until the outside temperature fell below −5.3 F. With the outside temperature at −20 F, the inside would still be above freezing at 35.3 F.

The 31-plate exchanger, although designed for an 18-cow barn, can be applied in a larger building with a decreasing degree of temperature control. If the same unit is applied in a 36-cow barn, the required air flow at the maximum design condition, −20 F outside temperature, is 5400 lb per hr (Fig. 1). To pass this amount of air through the exchanger would require an excessive amount of power. However, the exchanger can be applied in this 36-cow barn using a constant supply of 3300 lb per hr of air, and supplying additional ventilation with an auxiliary fan. A two-speed auxiliary fan could supply an additional 2500 lb per hr up to 10 F outside temperature and then supply 4000 lb per hr from 10 F on. Applied in this manner, the exchanger would permit this barn to be maintained at 50 F until the outside temperature dropped below 1.8 F.

There is an advantage in using the exchanger as mentioned in the examples above with a constant supply of air to the exchanger and supplying additional ventilation by means of auxiliary fans. Fans for the exchanger could be chosen with one operating condition and a high efficiency could be obtained. When additional heat was no longer required in a barn, the valves in the ducts would be closed and no air circulated through the exchanger. The decrease in system resistance would allow a greater volume of air from the fan, which would be needed in periods of mild weather. The duct valves could be easily adapted for thermostatic control. For the small volumes of air required in addition to that supplied by the exchanger, one or two small two-speed auxiliary fans could be used and thermostatically controlled to give complete automatic control of the ventilation in a barn. For completely automatic control, any particular animal shelter would need to be analyzed individually, as was done in the preceding examples, so that proper fan selection could be made for the system.

Another operational possibility for the exchanger, if properly developed, would provide ideal operating conditions. As the outside air temperature rises, the air volume required to remove moisture in an animal shelter increases. At the same time, the need for additional heat in the building decreases. If the air valves in the exchanger ducts were so designed that they could be modulated with a thermostatic control, they could be gradually closed to permit less air to be circulated through the exchanger as the need for additional heat becomes less. There would then be a smaller and smaller friction loss in the system and an increasing supply of air would be supplied by the fans. This system would provide the ideal in operation, maintenance, and control of the system.

SUMMARY

Heat exchangers have been found to improve animal-shelter ventilation during cold weather in providing a source of supplemental heat, and therefore a greater allowable ventilation rate, by using the otherwise wasted heat energy of the exhaust air to warm the incoming fresh air. An improved heat-exchanger design was developed for use in animal-shelter ventilation, utilizing the principle of plate-type exchangers to provide a light, compact, symmetrical unit facilitating handling, installation, and operation.

A laboratory test of the unit showed that in an 18-cow dairy barn it would permit complete ventilation and still maintain the barn temperature above 50 F until the outside temperature fell below −8.2 F; without the exchanger this critical temperature would be 12.7 F. With −20.0 F outside temperature, the barn temperature would remain above freezing at 38.2 F and still allow sufficient ventilation for complete moisture removal.

From the laboratory test an experimental relation was derived for determining the heat-transfer coefficients for this type exchanger, and a design procedure was developed for extending the basic unit to buildings of any size.

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Correlation of Machinery and Conservation Practices

By John R. Carreker
MEMBER ASAE

GREAT advances have been made in conservation farming and in the use of mechanized equipment during recent years in the Southeast. These two movements have been so closely allied that each became a part of the other. Other changes have also taken place.

In Georgia, for example, the farm population has declined about 35 per cent, but income per farm person has trebled. The total agricultural output per farm person has doubled. Cotton acreage has gone down—yields have gone up. The value of the peanut crop increased from about 10 million dollars in 1924 to approximately 90 million in 1948 to 60 million in 1950. Tobacco, the third most important cash crop, increased from 7 million dollars in 1924 to 50 million the past few years. So it is with other crops. There has been a tremendous increase in small grain acreage. Pasture acreage has doubled and the quality of pastures has greatly improved.

The results of these changes are more far-reaching than the cold statistics reveal. In addition to such changes as farm population, source of income, increase in size of farms, increase in owner-operated farms, and better land-use practices, an outstanding change has taken place in the widespread adoption of labor-saving farm equipment.

In 1920 there were 2,252 tractors on Georgia farms, by 1925 the number practically doubled, and today it is about 60,000 tractors. The potential market and, more important, the need is triple this number. Accessory equipment for use with these tractors has increased proportionately. It would be trite to say that mechanization was responsible for all the changes that have taken place in our agriculture. It has been one of the most important single contributing factors.

The term "conservation farming" means many things.

There are water-management practices such as draining wet land and constructing farm ponds. Both add to the productive ability of farms on which they are properly employed.

Other conservation practices include retiring land too steep for cultivation to perennial grazing crops and forests. These areas then need proper management.

Planting perennial sods such as the tall fescue grass, Coastal Bermuda grass and Bahia grass, alone and in combination with adapted legumes, has become a widely adopted conservation practice.

All of the foregoing are, to a large measure, specialized practices. Each has a specific place in the soil and water conservation program. Widespread use of each is now possible because equipment is available to carry out these practices.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the Soil and Water Division.

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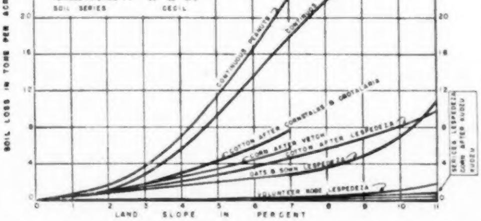

This graph shows average annual soil losses from selected cropping practices on terrace-interval slope lengths

Mechanical trenchers and tile-laying machines make tile drainage a fast and accurate operation. Draglines and other types of excavating machinery are used widely for constructing open-drainage channels. A very active program of drainage work has been under way several years at many locations throughout the South.

Machines to speed up the planting of grass stolons are now in use. Mechanical tree planters that now do the work formerly done by many laborers are being made available to an ever-increasing number of farmers. For example, the Georgia Bankers Association recently placed at least one mechanical tree planter in each soil conservation district in Georgia.

Terraces and associated outlets are necessary on most of the cropland in the South. Both heavy equipment and farm tractors and plows are used for building terraces and shaping outlets. The heavy equipment a few years ago consisted primarily of track-type tractors and blade graders. Now the motor grader has largely replaced the former machines. Bulldozers are used extensively for filling gullies and other work in connection with the terraces.

Bulldozers and other heavy equipment are also being widely used for clearing and renovating land for crops and pastures. Clearing hedgerows to connect adjoining fields, filling gullies, removing rocks and other such jobs permits more efficient use of farm power equipment. A very active program of such work is now under way in Alabama.

Land clearing, terracing, planting trees or perennial sods, building ponds and draining wet land are specialized practices. They are important components of an over-all soil and water-conservation program.

In the South the principal causes of soil deterioration and reduced crop yields are excessive runoff, erosion, loss of organic matter, poor soil structure and loss of plant nutrients on the cultivated land.

Results of soil-loss measurements for a number of cropping practices at the Southern Piedmont Conservation Experiment Station, Watkinsville, Ga., are presented in the accompanying graph. The losses from continuous row cropping to peanuts and cotton were excessive on all but nearly level land. As the quantity of ground cover was increased, the amount of erosion was reduced. Runoff was also reduced with these better cropping practices.

Yields of the row crops were markedly increased on all slopes when grown in rotation with the soil-conserving crops. The soil organic matter was renewed at intervals and soil structure was improved with the conservation crops.

In other Station studies where the rotations included fescue grass and legumes in sequence with cotton and corn, even more striking results in yield improvement and better soil condition were obtained.

Dr. W. M. Meyers of the U.S. Department of Agriculture stated recently (4)*, "... improved grasslands are required in crop rotation for sustained maximum production of other crops in that rotation. No other cropping system has yet been devised for American agriculture, that will maintain the organic matter of the soil, except rotations that involve adequate quantities of grasses and legumes."

The availability of adapted mechanical equipment now makes it possible for the agriculture of the South to include the necessary grass and legume components in rotations with the traditional row crops of cotton, corn, peanuts and other crops. These additional grass and legume crops are a vital part of the rapidly expanding livestock program now under way.

In the case of a typical rotation that includes (a) oats,

*Numbers in parentheses refer to the appended references.

fescue grass and Ladino clover, (*b*) fescue grass and clover, and (*c*) cotton, the sequence of operations and implements includes:

1. Cut cotton stalks in October.
2. Prepare seedbed by turning and disking in October.
3. Apply fertilizer and plant oats, fescue grass and clover seed in October.
4. Apply nitrate fertilizer topdressing in early spring (March).
5. Combine harvest seed in June.
6. Apply broadcast application of fertilizer in fall (October).
7. Combine harvest grass seed in June.
8. Harvest grass and legume hay (June).
9. Turn sod for row crops (February).
10. Prepare seedbed by disking (March).
11. Plant and then cultivate row crop.
12. Apply insect poisons to row crops.
13. Harvest row crops.

Grazing is obtained from the grass and legumes during the fall, winter and spring, beginning with the second year's growth, and again during the fall and winter prior to the sod being turned for row crops.

The sequence of machines required in this rotation cycle is indicated by the several operations listed.

Better conservation could be obtained through the development of new machines and procedures at two points in the rotation cycle. A machine is needed that will plant the seeds of the sod crops between the rows of the standing mature row crop plants. Then the row crop stalks could be cut onto the land with a rotary stalk cutter, thus using this plant material as a mulch during the first part of the sod crop phase of the rotation.

Secondly, more satisfactory means are needed for retaining the sod crop residues partly on the soil for surface protection and partly in the soil for structural improvement when row crops occupy the land. The leads offered by Lillard et al (3) with the double-cut turn plow, and by Nutt (6) with the disk harrow plus spring-tooth ripper, point the way toward a solution of this need.

Most of the cultural operations should be performed along and between the terraces on sloping fields. Modern tillage and planting tools equipped with power operated angling and lifting devices make such work much easier. The self-propelled combine is especially adapted for use between terraces.

The greater need at present is for improving the terrace layout pattern and terrace cross section to facilitate the use of available equipment. Jacobson's (2) plan for making terraces parallel has some merit and some definite limitations in the South.

A practical approach to the crooked terrace and short-row problem in the South is found in utilizing every available depression within the field for sodded waterways into which to outlet the terrace water. This, plus care in locating the terraces on the field gives shorter terraces, better alignment, fewer short rows and easier construction and maintenance. All these benefits facilitate the use of modern machinery for producing any crop desired.

Another example of conservation farming through mechanized farming is found in the recent developments in peanut production. Experiment station tests and farmer experience have shown for many years that peanuts were either soil building or severely soil depleting, depending on the method of harvest.

Where the nuts were hogged off, the leguminous plant material left on the land made peanuts a soil improving crop. Where the entire plant (tops, roots and nuts) was removed from the land in the conventional hand harvesting method of nut production, this crop was seriously soil depleting.

New machines are just now going into commercial use that dig and shake the plants, pick and sack the nuts, and place the vines and roots back on the land. These developments should be of inestimable value to the peanut producing area through the return of the plant materials to the soil.

CONCLUSIONS

Through the application of modern machinery to production techniques, we now have the means of applying the soil and water conservation practices so long needed in the agriculture of the South. Whatever those practices are—draining wet land, building ponds, constructing and maintaining terraces, growing crops in conservation rotations—mechanization now makes them practical. Through the use of machinery, conservation measures are now being established that will be the means of sustaining maximum production throughout generations to come and give economic returns at the present time.

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(*Continued on page 643*)

(*Upper left*) Kentucky 31 fescue grass being turned in March for planting row crops • (*Upper right*) Examining the mulch on the soil surface in September in the corn where fescue grass was turned in March • (*Lower left*) Examining the mulch on the soil surface after cotton stalks are cut with a rotary-type cutter • (*Lower right*) A self-propelled combine harvester is opening up a field of wheat along a terrace. The terraces are not crossed and no grain is trampled with this machine

Soil and Water Management under the Complete Watershed Program

By Howard Matson
MEMBER ASAE

IN THIS paper the phrase "soil and water management" will be considered as including all phases of the conservation, use and control of soil and water resources. Agricultural engineers know that soil and water are so closely interrelated that one cannot be considered apart from the other, and that whatever is done to one of these resources inevitably affects the other. That is the basic reason why a watershed is the only physical unit on which all soil and water problems can be investigated and dealt with in accordance with their needs and in their proper relationship.

Considered functionally, the various phases of soil and water management involved in a complete watershed program may be grouped under the following three general categories:

1. Watershed protection or stabilization and soil improvement
2. Water conservation and use
3. Flood prevention and drainage.

The first and basic step in soil and water management on any watershed must be the protection or stabilization of the watershed. The land must be used in accord with its capabilities and treated in accord with its needs. To me, "the land" doesn't mean just the acres which are used for cultivation, or for pasture or range, or for woodland, or wildlife; it includes the gullies, the roadside ditches, the waterways and stream channels. Of course the proper use and treatment of the land involves all of the agronomic, pasture and range, forestry and engineering practices and measures needed for the conservation and improvement of the soil, but it should also include all of the structures needed for gully control, for roadside erosion control, and for the stabilization of waterways and stream channels and banks.

An adequate job of watershed protection will accomplish the maximum reduction in erosion rates (and sediment production) and the maximum increase in infiltration consistent with agricultural use of the land. The greatest benefits from watershed protection are the conservation and improvement of the soil and the resulting increases in agricultural production, but its benefits do not stop there. The increased infiltration on the watershed will produce minor but significant reductions in flood peaks and resulting floodwater damages. The decreased sediment production rates will effect major reductions in sedimentation damage to alluvial land, reservoirs, stream channels, harbors and waterways, drainage and irrigation systems, and other improvements. In many cases the construction of reservoirs for municipal or industrial water supply, irrigation or flood control may not be economically feasible until sedimentation rates have been reduced by watershed protection.

There are many aspects to the conservation and use of water. The same measures and practices which are needed for watershed protection and soil improvement also, by increasing infiltration, make a larger proportion of the annual precipitation available for plant use, for increasing the base flow of streams, and for recharging ground water aquifers. Where watershed conditions are suitable, water spreading may be feasible to increase crop or forage production or for groundwater recharge. Where irrigation is practiced, proper land leveling and the efficient distribution and application of water are effective means of conserving irrigation water supplies. In most watersheds there is a need for one or more reservoirs for water storage, ranging from small ponds for domestic and livestock water supply, fire protection, recreation and wildlife production to major reservoirs for municipal and industrial water supply, irrigation or power development or a combination of uses.

In many tributary or "creek" watersheds one of the major water problems is the frequency and severity of flooding. In his statement last April 22 before the Special Subcommittee on Civil Works, of the House Committee on Public Works, Secretary of Agriculture Charles F. Brannan pointed out that about 75 per cent of the average annual floodwater and sediment damages occur in the valleys of tributary streams. In many river watersheds the aggregate area of flood plain in the tributary valleys is two to three times as great as the area of the main stem flood plain, and the tributary valleys are flooded much more frequently. Also, a large amount of flood protection already has been afforded in many major river valleys by

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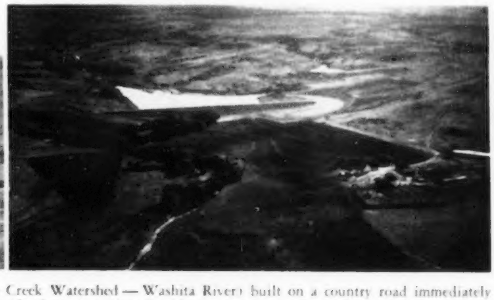


(Left) This picture shows a small sediment-control structure (Sandstone Creek Watershed — Washita River) built on a country road immediately below the junction of high sediment-producing gullies. The earthen embankment, equipped with 48-in corrugated metal drop inlet pipe, was constructed to retain sediment from the gullied area while good vegetative cover was being established. The purpose of such structures is to prevent too rapid sedimentation in floodwater-retarding structures built across principal drains some distance downstream • *(Right)* This picture shows a floodwater-retarding structure on the Sandstone Creek Watershed, Washita River project. The surface area of the permanent pool is 17.8 acres, and the flood pool 29 acres, the total storage equivalent to 5.98 in of runoff from the 790-acre drainage area. An uncontrolled 12-in pipe slowly releases floodwaters temporarily stored above the dam. A vegetated emergency spillway, 80 ft wide, shown on the right end of the embankment, is capable of handling the runoff from a 100-year frequency storm with the flood pool full at the time of occurrence. The bottomland shown below the structure is part of the 4700 acres of flood plain on Sandstone Creek which will be protected by a system of 24 floodwater-retarding structures. The small pool in the background to the right of the farmstead is a farm pond.

levees and floodwalls, channel improvements and major reservoirs.

The frequent flooding of the valleys of tributary streams not only causes high annual flood damages, but has other detrimental effects on agriculture. In many tributary valleys flooding is so frequent that only a relatively small per cent of the flood plain can be used for cultivated crops, most of it being suited only for pasture use or feed production. This means not only that a low level of production is being obtained from the land which is most fertile and least subject to erosion, but the economic necessity of growing the cultivated crops on the upland portions of the watershed makes it difficult for farmers to use the upland in accord with its capabilities and maintain or establish permanent cover on areas not suited for cultivation. Flood protection for tributary valleys is a great help in achieving proper use and treatment of upland areas.

As Secretary Brannan said, in his statement previously referred to, watershed programs should be designed to achieve the maximum practicable degree of reduction of erosion, floodwater and sediment damages, and the principal flood-prevention objective should be reduction of agricultural damages in tributary valleys above major protection and control works. As already stated, increased infiltration due to watershed-protection practices and measures will reduce flood peaks to some degree. Also, some further reduction in flood peaks may result from the construction of drop-inlet-type structures for gully control or grade stabilization. But to achieve the maximum practicable degree of reduction of floodwater damages in the valleys of tributary streams usually will require structures specifically designed for that purpose.

Where topography and other conditions are suitable, a system of floodwater-retarding structures, or detention reservoirs, in a watershed is probably the most effective and economical method of flood prevention. If such structures can be so located that they will control (partially) the runoff from 60 to 80 per cent of the watershed area, it will be possible to eliminate most of the flood damage and greatly reduce the damage caused by runoff resulting from infrequent major storms. Other structural works such as floodwater diversions, levees, debris basins, floodways or channel improvement may be needed in conjunction with, or in lieu of, systems of floodwater-retarding structures.

Surface drainage is closely associated with flood prevention, being another form of the control and disposal of surface runoff. In many cases surface drainage improvement is not practicable until flood protection has been provided, because of the difficulty and expense of maintaining surface drainage systems in areas which are frequently flooded. Ordinarily surface drainage systems are not designed to prevent flooding, but rather to remove excess surface water rapidly enough to prevent major crop damage.

Tile drainage is necessary where internal drainage in the soil profile is inadequate to remove an accumulation of excess water in the crop root zone. Usually this restriction of internal drainage is due to an underlying impervious soil stratum. Open drainage ditches may be needed in conjunction with tile drainage to remove excess surface water, or to provide gravity outlets for tile drains, or both.

In the foregoing discussion of the major phases of soil and water management and their objectives, an attempt has been made to show the close association and interrelationship which exists between these various phases. By collecting needed physical information, analyzing all pertinent available data, and weighing alternative possible solutions of problems by evaluating their probable effects, it is possible to develop an integrated and complete watershed program. In general, the following steps are necessary in formulating a complete watershed program and evaluating its feasibility:

1 Inventory of physical land conditions and capabilities

2 Inventory of present land use and crop distribution

3 Determination of needed practices and measures for watershed protection and soil improvement, recommended future land use, and expected crop distribution

4 Inventory of sedimentation conditions and sediment production rates by sources, under present conditions and expected future conditions

The SCS technician in this picture is examining a gully which has been healed by a 12-year-old planting of a native grass mixture, of which the predominating grass is little bluestem

5 Inventory of significant water problems, including irrigation, water supply, flooding and drainage

6 Inventory of present flood-plain land use and crop distribution, and annual flood damages

7 Study of rainfall-runoff relationships under present conditions and determination of expected rainfall-runoff relationships after installation of needed practices and measures for watershed protection and soil improvement

8 Planning of developments or improvements for water conservation and use

9 Planning of structural works for flood prevention and drainage

10 Hydrologic analysis of effects of developments or improvements for water conservation and use and structural works for flood prevention and drainage on flood peaks and volumes, water yield, and water quality

11 Economic evaluation of benefits and costs of various phases of the watershed program, including consideration of the costs of installation, operation and maintenance.

In summary, soil and water management under the complete watershed program involves the collection of needed physical data on watershed conditions and problems; intelligent analysis of this information to determine the relative importance and interrelationship of the various physical factors; formulation of an integrated program for the conservation, control and use of soil and water resources, and evaluation of its physical effects and economic feasibility.

The Engineering Revolution in Agriculture

(Continued from page 616)

which will insure our children a land in which to live without poverty and perhaps without reduced living standards, but I am concerned sometimes about this thing called "freedom."

This liberty or freedom, as you may call it, is the basis of all the things which we hold dear. Our empire with all of its machines, with all its capacity to produce would be but an empty shell without the freedom for which our fathers and sons have fought and died. We must not lose it either from without or from within, but to hold it we must regain some of those bold traits by which our forefathers conquered the West —traits of industry and thrift, faith in our fellow men, and faith in our country. Our young men must think more about opportunity and less of retiring on a pension; think more of discovering new worlds to conquer and less of getting more from the old one without working for it.

Freedom can be lost. In the last 2,000 years only 5 per cent of the population of the world has lived in freedom as we know it. Let us guard it well in the years to come and remember that immortal phrase: "Eternal vigilance is the price of liberty."

Factors in the Design of Baled-Hay Driers

By Vernon H. Baker and James L. Calhoun
MEMBER ASAE MEMBER ASAE

THERE has been a substantial increase in the quantity of hay baled in the United States during the past twelve years. The proportion increased from 14.5 per cent in 1939 to about 47 per cent in 1948 (1).* It is estimated that more than 50 per cent of the hay produced in this country in 1951 was baled.

Hay-drying research has been conducted at the Virginia Polytechnic Institute in cooperation with the Division of Farm Electrification, Bureau of Plant Industry, Soils and Agricultural Engineering, U.S. Department of Agriculture, for a number of years. This work produced a version of the slatted-floor hay drier that is now in wide use for long and chopped hay (2, 3). A study of basic factors involved in drying baled hay was started in Virginia in 1949 (4, 5). Other investigators had made studies on baled hay prior to these studies (6, 7, 8, 9). Before the Virginia studies began, several farmers installed driers for baled hay. The operation of these systems was observed closely. With facts obtained from research and field experience, baled hay driers that will do a satisfactory job of drying can now be designed.

It is realized that drying systems, other than the slatted-floor arrangement, have given satisfactory results in various parts of the United States; however, this paper will be concerned mainly with factors to consider in the design, operation and management of the types of baled-hay driers that have proven satisfactory in Virginia. The air-distribution systems described in this paper could be used, with some modification, to dry long and chopped hay; however, the baled-hay drying plans will only be considered here.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The authors: VERNON H. BAKER and JAMES L. CALHOUN, respectively, associate agricultural engineer on leave from Virginia Agricultural Experiment Station, and associate agricultural engineer, Virginia Agricultural Extension Service, in cooperation with division of farm electrification (BPISAE), U.S. Department of Agriculture.

*Numbers in parentheses refer to the appended references.

BASIC FACTORS

The four basic factors to consider in the design of a drier for baled hay are: (*a*) amount and kind of hay to be harvested by baling, (*b*) natural air or supplemental heat, (*c*) location of drier, and (*d*) air-distribution system.

Amount and Kind of Hay Grown. The quantity of hay produced on a particular farm determines to a large extent the size of drier to install. One of the first things to consider is the maximum amount of hay that must be dried at one time. Greater use can be made of the drying system if the hay crop is harvested several times during the season. Alfalfa is a crop that is well adapted for drying by artificial means. Since it is usually harvested in three to five cuttings each year, the drier is in use a large portion of the summer season.

If a drier is designed to handle the first cutting of alfalfa, it will be of ample size for future cuttings. For design purposes, an estimated first cutting yield of 1½ tons per acre may be assumed. For other hay crops, forced natural-air systems should be designed to handle the maximum amount of hay to be harvested within a one-to-two-week period. Systems with supplemental heat have greater drying capacity.

Natural Air and Supplemental Heat. Several factors must be considered in determining whether to use forced natural air or supplemental heat for a given situation. Both of these methods are giving satisfactory results in Virginia. Most of the present installations use natural air, but there is a growing interest in the use of supplemental heat in drying baled hay. The reduced drying time with supplemental heat makes it possible with a given size of unit to dry a larger quantity of hay during the season than is possible with a natural air system. Also better drying results can usually be obtained when supplemental heat is used. With a 7½-hp fan unit using unheated air, the maximum capacity is about 1,600 bales, or 40 tons of hay per cutting. If the quantity to be dried exceeds this amount, it is well to consider the use of supplemental heat. This is true because two natural-air systems may cost as much

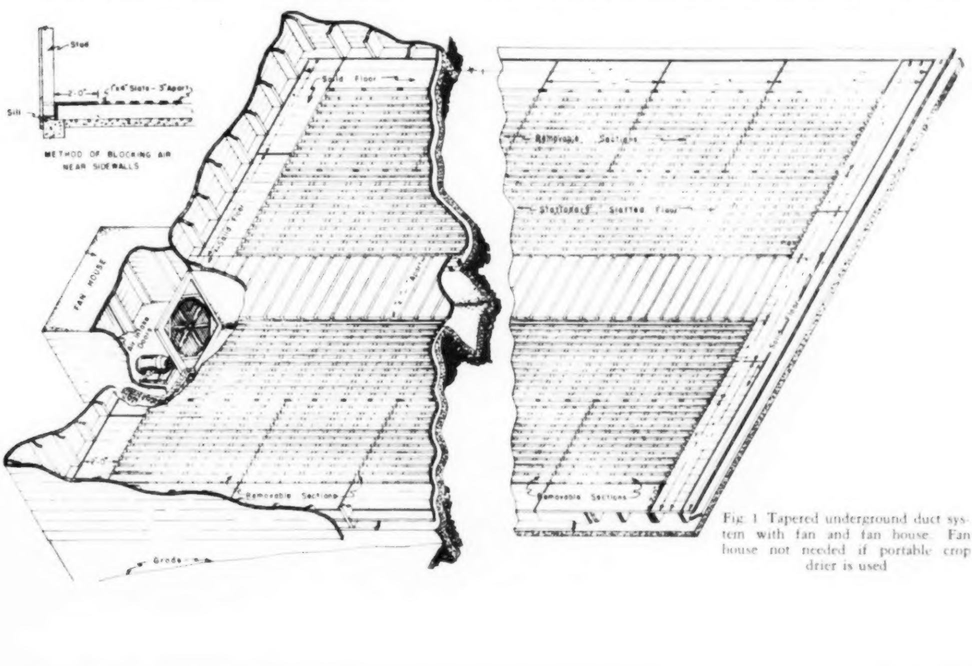


Fig. 1 Tapered underground duct system with fan and fan house. Fan house not needed if portable crop drier is used

as a single unit using supplemental heat. In general the cost of electricity for a forced-natural-air system is slightly lower than the cost of electricity and fuel oil for a system using supplemental heat. The cost of fuel and electricity for drying baled hay will probably be between \$2 and \$3 per ton.

There are other factors which govern the choice of methods. If there is a suitable building on the farm which provides adequate space for the drier, consideration should be given to using forced natural air. This type of system will usually be lower in first cost, and it can be expected to give satisfactory results. If, on the other hand, no suitable building is available, and if hay is stored and fed in two or more places on the farm, it may be advisable to use a portable crop drier. With this drying unit, the hay can either be dried on a portable wooden rack in the field, or it can be dried in an inexpensive shed built for the purpose. Also, if a farmer plans to dry such other crops as corn and small grain, he should consider the purchase of a portable crop drier with supplemental heat (10).

Location of Drier. As is indicated by the above discussion, the choice of forced natural air or supplemental heat has a definite bearing on the location of the drier. A baled-hay system can be placed in any structure which provides adequate space, protection from the weather, proper drainage and ventilation, and a minimum of obstructions in the mow. These driers can be installed in haymows above ground or at ground level. The floors in aboveground mows must be strong enough to support the wet hay. If an appropriate building is available for the drier which will fit into an efficient hay-harvesting management program, it should be used. This will make it possible to install the drier at minimum cost. If a special structure is to be built for the drier, it should be planned to serve other purposes also. For example, such a building can be used for the storage of farm machinery during the winter months, or for drying other crops.

Good drainage is of great importance for installations at ground level. If surface-drainage water or other excessive moisture is permitted to enter the area occupied by the drier, the effectiveness of the system will be reduced. Where possible the drying area should be located at a level above the natural grade line.

AIR DISTRIBUTION SYSTEM

There are several types of air-distribution systems for drying baled hay. In many cases any one of the different types may be satisfactory, however, certain of these systems have definite advantages for a particular set of conditions. Five different types for baled-hay driers are discussed in the following paragraphs.

Underground Main Air Duct. This system is adapted only for installations at ground level (Figs. 1 and 2). It can only be used in areas that are well drained. Since the main duct is below ground level, the problem of drainage must be given careful consideration. If a location meets drainage requirements, a system using the underground main duct is highly recommended. Its construction permits the use of a level slatted floor over the drying area. This feature simplifies the problem of stacking and removing bales from the drier. It can be installed using either a dirt or a concrete floor. The sidewalls of the main duct should be constructed of concrete or masonry blocks. The floor of the main duct should be covered with a thin layer of concrete. If a dirt floor is used under the slatted floor area, 2 x 8-in treated lumber should be laid lengthwise of the drying area to support the slatted-floor sections slightly above ground level. By making the slatted floor in sections small enough for easy handling, they can be removed after the hay-drying season, thereby making the drying area available for other purposes during the winter months. The 2 x 8-in boards across the top of the main duct can be used to cover the main air duct when the building is used for purposes other than for drying hay.

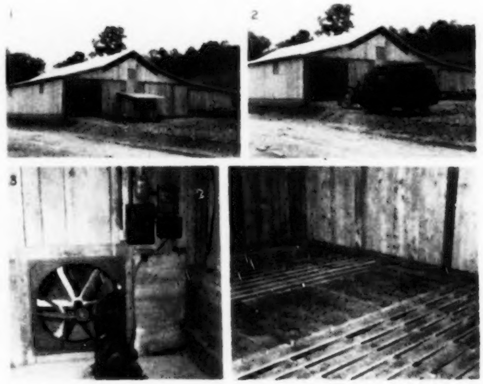


Fig. 2 *(Upper left and right)* Baled-hay drying structure with two natural air systems installed at each end of structure • *(Lower left)* Fan, motor, and motor controls • *(Lower right)* Part of covering over underground duct and slatted floor

Center Main Duct, Constant Height and Width. The applications for this type of air-distribution system (Fig. 3) are limited. It should only be recommended in situations where the drier can be loaded and unloaded from both sides. For accessibility it is also advisable where it is desired to use air-

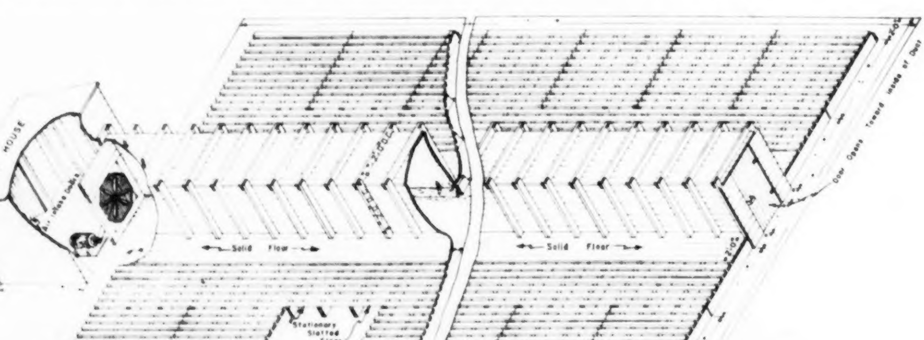


Fig. 3 Center rectangular main air duct system with slatted floor

regulating gates at the bottom of the main duct to divide the drier into sections for handling small quantities of hay. With these air-regulating gates it is possible to load one side of the drier, and after the drying is completed the other side can be loaded. While the last batch of hay is being dried, the first loading can be removed from the drier into storage. For a natural air system it is doubtful that this method of loading is of value. It can, however, be used quite effectively where supplemental heat is used, because two drying areas improve the efficiency of the operation.

The center main duct, without a slatted-floor, air-distribution system, has been used successfully in some areas to dry baled hay. The center duct is made of rigid frame construction covered with slats, or the duct frame is covered with heavy wire. With this type of construction, it is important that the bales be stacked around the duct so that the air travels equal distances through the hay in all directions.

Side Main Air Duct. This type of air-distribution system has wide application on Virginia farms (Fig. 4). By placing the main duct along one of the sidewalls of the mow, it provides a level slatted floor over which to stack the bales. The main duct is out of the way and does not interfere with loading and unloading the drier. The side main duct is especially adapted for use in aboveground mows. It is also recommended for special hay-drying sheds at ground level located in poorly drained areas. This type of system has only limited application in beef-cattle barns and dairy loafing barns which have hay storage at ground level. In these structures a main duct along one side of the mow may interfere with feeding of the hay.

Side main ducts can be constructed of constant height and width, or they can be tapered in height. In mows which have a vertical sidewall, a main air duct tapered in height may be used. For aboveground mows in barns with gambrel roofs, it is often advisable to use a constant height and width duct. The braces which usually extend to the floor of some mows make it rather difficult to build a tapered duct. Main ducts of constant height and width should be large enough so the maximum air velocity will not exceed 1,000 fpm. On the other hand, a velocity up to 1,600 fpm is permissible in ducts tapered in height. The main duct is built airtight, with the exception of the air opening that permits air to enter the sections of slatted floor.

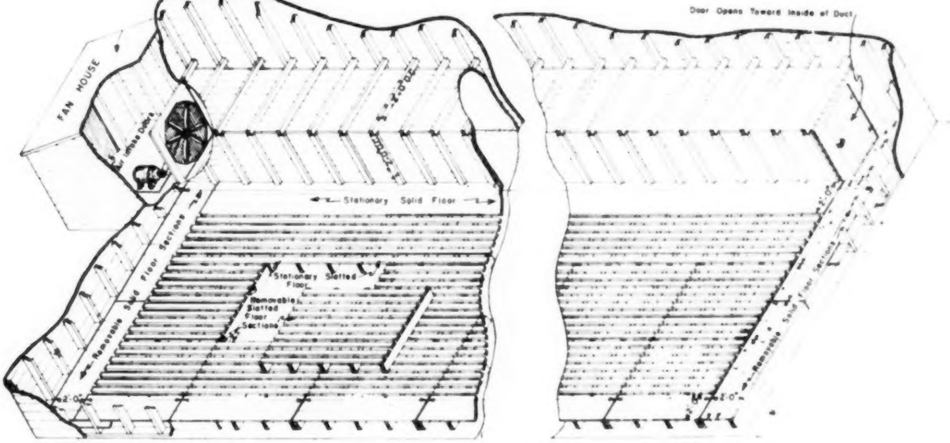
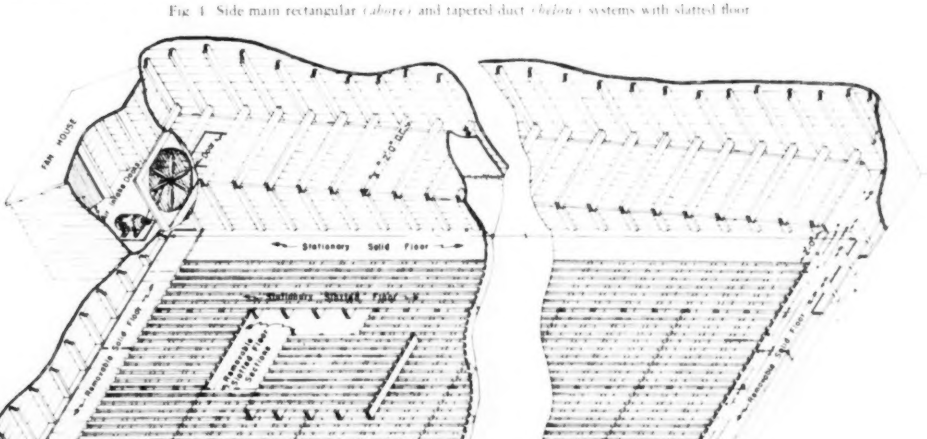


Fig. 4 Side main rectangular (*above*) and tapered duct (*below*) systems with slatted floor



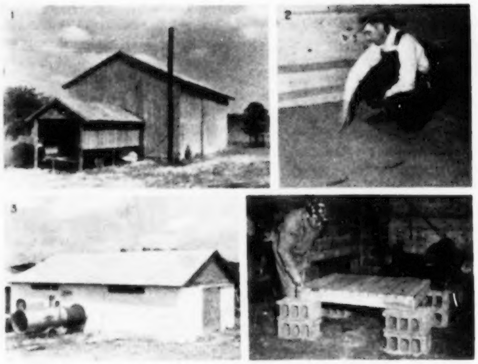


Fig. 5 The batch drier. (Upper left) Portable crop drier with sheet metal structure. (Upper right) Perforated steel floor. (Lower left) Masonary two-compartment batch drier with portable crop drier. (Lower right) Removal floor for batch drier, used for machinery storage in winter

Some of the pertinent facts concerning these two types of main air ducts are listed below:

RECTANGULAR, CONSTANT HEIGHT

1. Easier to build
2. Requires more lumber and other materials
3. Desirable if air-regulating gates are to be used
4. Maximum air velocity, 1,000 fpm
5. Desirable in mows with gambrel roofs

TAPERED, VARYING HEIGHT

1. Requires more sawing and fitting in construction
2. Requires minimum of lumber and materials
3. Provides even air distribution with higher velocity
4. Maximum air velocity, 1,600 fpm
5. Saves mow space above main duct for storage

Plenum Chamber Drier. The use of a portable crop drier and a plenum-chamber air-distribution system is becoming popular among farmers who plan to dry corn and small grain in addition to hay (Fig. 5). This system should be centrally located between the storage buildings and hay fields. After a loading of hay has been dried it is then moved to storage.

With this system air is blown into a plenum chamber underneath the drying area. The height of the plenum chamber should be at least 2 ft. Three types of floors may be used in a plenum-chamber drier, perforated metal, wooden slats and hardware cloth covered with screen wire. The perforated metal floor is made commercially and is available with openings that will not allow small grain to pass through. The wooden floor is generally made of 1 x 4-in lumber with from 1 to 3-in openings between slats.

Field Drier. Recommendations on drying baled hay in the field or under a permanent cover should be based largely on the conditions existing on each farm. Field drying is practical in some situations. In most cases, however, farmers prefer a more permanent drying building or shed. A wooden rack is recommended for field drying instead of depending upon the bales to form the air ducts. This drying rack (Fig. 6) should be made in sections for ease in moving it from one area to another. A disadvantage of the field drier, in many cases, is the additional expense of providing electric service at the location where the drying unit is to be placed.

A tarpaulin should be used to cover the bales during drying in the field. It has two purposes: (a) to protect the hay from the elements and (b) to cause the air leaving the hay to sweep the outside edges of the outer bales and thus facilitate drying.

FUNDAMENTAL DESIGN FACTORS

Area and Density of Baled Hay. For most effective drying, loose twine-tied bales are recommended. Many balers can be adjusted for different lengths of bales. For convenient handling and stacking on the drier, bale lengths of 30 to 36 in are desirable. (See Tables 1 and 2 for volume and density of baled hay.)

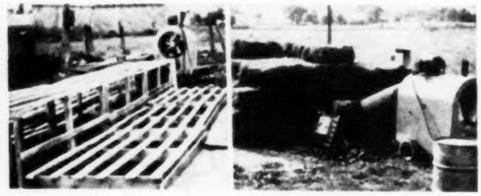


Fig. 6 Portable baled-hay drying racks and crop drier for use in the open field

For best results, no more than six layers of 35 per cent moisture hay should be placed on a drier with an air flow of 20 to 25 cfm per sq ft of floor area. It is possible that more layers with a lower moisture content may be dried at one time. It is not recommended that a second loading of hay be stacked on top of hay that has already been dried. Instead the dried hay should be removed from the drier leaving the system free for the next loading.

Calculations for Selecting Fan. One bale 14 x 18 x 36 in on edge will cover about 4 sq ft of area (Table 1). Six bales stacked on edge, one on top of the other, will occupy about 40 cu ft. Suppose we have 20 acres of hay with 1.5 tons per acre for first cutting [approximate yield for Virginia at 20 per cent moisture (wet basis)]. Then 20 × 1.5 × 300 = 9,000 cu ft. Dividing 9,000 cu ft, the total volume of hay, by 40 and then multiplying by 4 sq ft will give 900 sq ft of floor space for 30 tons of 20 per cent moisture hay stacked six layers deep. This same hay at 40 per cent moisture will occupy about the same volume and floor area, but will weigh 40.5 tons.

TABLE 1 AREA AND VOLUME OCCUPIED BY BALED HAY

Size of bale, in	Volume of bale, cu ft*	Approx. vol. per ton, cu ft*	Approx. no.** bales per ton	Floor area, occupied per bale on edge, sq ft*
16 x 18 x 36	7.50	300	40	4.6***
14 x 18 x 36	6.65	300	45	4.0

*Adjusted to allow for expansion of bale after removal from baler and for distance between bales when stacked on drier.

**At 20 per cent moisture, wet basis.

***A bale stacked on 18-in side will occupy about 5.12 sq ft floor space.

After the area of the drying floor has been determined, the fan unit for a forced-natural-air system can be selected. Fans for these systems should be capable of delivering a minimum of 20 cfm per sq ft of drying-floor area at ¾ in of static pressure. A portable crop drier using supplemental heat should deliver a minimum of 20 to 25 cfm per sq ft of drying area at ¾ in of static pressure. Another guide in design is to be sure the source of air is of sufficient volume to provide about 600 cfm of air per ton of hay at 20 per cent moisture. In the example above, the minimum volume of air required for six layers would be 20 × 900 = 18,000 cfm, or using 30 tons × 600 cfm = 18,000 cfm of air required. The fan and motor horsepower can be selected from manufacturers fan tables using ¾ in of static pressure and the total air requirements calculated above.

Size of Main Air Duct. Main air ducts built at constant height and width should be large enough to provide a max-

TABLE 2 WEIGHT AND DENSITY OF BALES AT VARIOUS MOISTURE CONTENTS

	Weight and density of bales at various per cent moisture, wet basis									
	20 per cent		30 per cent		40 per cent		50 per cent		60 per cent	
Size of bale, in	lb	lb per cu ft	lb	lb per cu ft	lb	lb per cu ft	lb	lb per cu ft	lb	lb per cu ft
16 x 18 x 36*	50	6.7	57.1	7.6	66.7	8.9	80.0	10.7	100.0	13.3
14 x 18 x 36**	45	6.7	51.4	7.6	60.0	8.9	72.0	10.7	90.0	13.3

*40 lb dry matter **36 lb dry matter

imum air velocity of 1,000 fpm. For example, if the fan delivers 27,000 cfm at ¾ in of static pressure, the main air duct should have a cross sectional area of at least 27 sq ft. For most propeller-type fans installed on systems with main air ducts tapered in height, the fan frame determines the size of the main air duct at the fan. If 2 x 4-in lumber is used for building the fan frame, the main air duct will usually be large enough to keep air velocity under 1,600 fpm for tapered ducts.

Air Openings at Bottom of Main Air Duct. The following formulas can be used in determining the height of the air opening at the bottom of the main air duct (3): For center main air ducts with slatted floor on each side, $W=Q\times(0.006/L)$ in, and for side main air ducts $W=Q\times(0.012/L)$ in. When W = width of crack in inches, Q = cfm of air the fan is rated to deliver against ¾ in of static pressure, and L = length of the air opening along one side of main duct in feet.

Drying Floor. For systems built of lumber, the drying floor should be constructed in sections for easy removal and for cleaning under them. The joists for the slatted floor must be as wide as the height of the air opening at the side of the main duct. For example, in using one of the formulas mentioned above, if the air opening figures to be 7 in high, then it is recommended that 1 x 8-in rough lumber be used for the joists in the slatted floor. Whether the walls of the building are solid or not, it is recommended that the air be blocked a distance of 2 ft from the side of the main duct and from all of the sidewalls. This can be done by placing a solid floor around the outer edge of the drying area as is shown in Figs. 1 to 5. The slatted floor can be made in sections of a convenient size for easy handling.

Air Intake to Fan. The velocity of the air through the fan-intake opening should not exceed 1,000 fpm. If this opening is made smaller, air delivery will be reduced and the fan will operate at a lower efficiency. The fan unit and the air-intake opening must be located so as to prevent recirculation of air that has passed through the hay.

Ventilation Above Drying Area. The drying area should be well ventilated. Unless good ventilation is provided, moisture will condense on the outer surfaces of the bales. There should be at least 1 sq ft of mow ventilation area for each 200 cfm of air delivered by the fan.

MANAGEMENT OF DRIER

Proper management of the drier is the key to successful results.

When to Bale. The hay should be baled just before it is dry enough for the leaves to shatter. Alfalfa hay should be baled at about 35 to 40 per cent moisture. The bales should be stacked on the drier as soon as possible after baling. If they are left in the field for only a few hours, they will heat and the hay will be damaged.

Stacking Bales on Drier. The bales should be stacked on the drier carefully. Place the cut edge of the bales toward the air flow. Tests have shown that baled hay dries faster when the air enters the cut edge of the bales. Stack the bales tightly together and break the joints between succeeding layers as much as possible (11). Any large cracks should be filled with loose hay. This stacking procedure will reduce unnecessary escape of air and will cause some of the air to pass through the bales themselves, which is a requirement for proper drying. Do not place more than six layers of bales on the drier at each loading. Best results have been obtained by not drying more than six layers at one time.

Operation of Drier. Start the fan as soon as one layer of bales has been stacked on the drier. For forced natural-air systems, follow the operation schedule shown in VFEC Publication No. 2 (12).

No standard procedure for operating portable crop driers, when drying baled hay, has been formulated. If time is a factor, it may be advisable to use supplemental heat day and night until the hay is almost dry. During good drying weather, some operators use natural air during the day and apply heat only at night. This method of operation may reduce the cost of drying. In any case, forced natural air should be used during the last few hours of operation to cool the hay. When portable crop driers are used, the temperature of the air leaving the hay should not be more than five degrees above atmospheric temperature. If the difference between these two temperatures is greater than five degrees, heat is being wasted.

Cost of Drying. Comparative operating costs of drying baled hay with natural air and with supplemental heat will depend on the prevailing electric rate, the cost of fuel used, and the ambient conditions where the drier is located. For example, assume a condition in which a given amount of baled hay is dried with a fan unit in 10 days with air at 70 F and 55 per cent relative humidity. Assuming a 5-hp motor is used for this period with an electric rate of 2½¢ per kw-hr, the operating cost would be $30. To raise the temperature of 15,000 cfm of air 20 F requires a fuel-burning rate of approximately 2½ gal of oil per hour, or 60 gal per day. Since the use of 20 deg of supplemental heat will reduce the drying time to about 4⅓ days, the operating cost would then be $3 per day for the motor and $9 per day for oil, with oil at 15¢ per gal. Thus the operating cost using supplemental heat would be about $52.

The fixed charges for drying baled hay with supplemental heat may be higher than for a system using forced natural air. A forced-air drier for a drying-floor area of 1200 to 1300 sq ft will cost approximately $1,000 to $1,200. This initial cost would be about doubled for a system with supplemental heat. It is obvious, therefore, that the annual fixed charges are higher where supplemental heat is used. This fact does not apply, however, when fixed charges are calculated on a per ton basis. A larger quantity of hay can be dried during the season with a portable crop drier than is possible with a single system using forced natural air. This larger capacity may reduce the fixed charges for supplemental heat to a comparable figure for forced natural air.

SUMMARY

A general discussion of the design, operation, and management of five different systems used in Virginia for drying baled hay is presented. These systems are the underground main duct, the center main duct, the tapered and rectangular side main duct, the plenum chamber drier, and the field drier. These systems, with minor modifications, can be used to dry long and chopped hay (3).

1 A design value of 1½ tons per acre of alfalfa for the first cutting may be used. For other hay crops a forced-natural-air system should be designed for the maximum amount of hay to be harvested within a one-to-two-week period.

2 The decrease in drying time with supplemental heat makes it possible to dry a greater quantity of hay during the season with a given system than is possible with natural air. Using natural air and a 7½-hp fan unit, the maximum drying capacity is about 1,600 bales of hay per cutting. If the quanity of hay to be dried exceeds this figure, it is well to consider the use of supplemental heat. This is true because the initial cost of two natural-air systems may equal that of a single unit using supplemental heat.

3 Rectangular ducts should have sufficient cross sectional area to provide a maximum air velocity of 1,000 fpm, whereas a velocity up to 1,600 fpm is permissible in tapered ducts.

4 The field drier discussed in this paper is recommended only as a temporary measure.

5 For design purposes, a 14 x 18 x 36-in bale of alfalfa hay at 20 per cent moisture can be considered to weigh 45 lb and occupy about 6.15 cu ft and covers 4 sq ft of area when stacked on edge. The 16 x 18 x 36-in bale at 20 per cent moisture weighs about 50 lb and occupies about 7.00 cu ft and covers about 4.5 sq ft of floor space when stacked on edge. A rule-of-thumb method for estimating the space occupied by baled hay is to use a figure of 280 cu ft per ton.

6 Fans for natural-air systems should be capable of delivering a minimum of 20 cfm per sq ft of drying floor area at ¾ in of static pressure. A portable crop drier, using supplemental heat should deliver a minimum of 20 to 25 cfm per sq ft of mow area at ¾ in of static pressure. Another guide in design is to use a minimum of 600 cfm of air per ton of hay at 20 per cent moisture. *(Continued on page 634)*

Relation of Farm Dairy Housing to Animal Health

By A. H. Groth and Merle L. Esmay

MEMBER ASAE

MODERN dairy cattle are, as a result of man's influence, decidedly artificial creatures. Through continued selection, primarily for ability to convert large quantities of grain and roughage into milk and butterfat, we have developed animals that are abnormal. There is little similarity between such cows and their early ancestors that produced only enough milk to feed their calves for a few months.

ADEQUATE CALF HOUSING

Our dairy cows are not only expected to produce large quantities of milk but also to conceive and reproduce, dropping a calf every 12 to 13 months. Furthermore, these modern dairy cows start their lives as calves that are permitted to remain with their dams for a period of only one to three days. They are then fed from a bucket twice daily, rarely three times daily. Unless these calves are reared in buildings or pens that are so located, arranged, and constructed to promote sanitation and health, there is little chance of growing healthy heifers into high producing cows.

On many otherwise well-managed and operated dairy farms the calves are all too frequently very much neglected. It is not surprising, therefore, that mortality in dairy calves averages about 20 per cent and morbidity is considerably higher. An important cause of death in young dairy calves is the scours-pneumonia complex. While infectious agents are generally considered to be the primary cause of the condition, predisposing factors are also important. Among these are improper feeding and improper housing.

The newborn of all species of domestic animals are quite susceptible to sudden changes in wet and dry-bulb temperatures and to cold drafts. Proper location, arrangement and construction of buildings can largely control these factors.

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The agricultural engineer in planning and designing such buildings must take into consideration the different sections of the country with their variations in climate and soil conditions, the type of housing used for the producing herd, and the conservation of time and energy in caring for the calves, as well as cost of materials and of construction.

Location of the calf-raising area in relation to the area occupied by older animals may be important from the standpoint of warmth in winter. It may also be important in causing fluctuations in temperature, especially if the cows are in the barn for feeding and milking and then are moved to the outside. Transmission of diseases and parasites may also be affected through proximity to adult cattle.

If calves are to be housed in the same building with older cattle, they should be in a part of the barn that can be reached by direct sunlight and protected from drafts. Individual pens are preferable when the calf is first removed from the dam and until it reaches its second or third week. Such pens are best provided with solid partitions on three sides. They reduce drafts and prevent spread of disease by direct contact.

Floors may be of a variety of materials and types of construction. Concrete that is properly insulated is satisfactory if kept well bedded. Too frequently the concrete is poured directly on the ground with improper insulation and with an inadequate moisture barrier. Such floors are invariably wet and cold. In addition calf barns and dairy barns are frequently poorly located from the standpoint of surface drainage.

Calves may be housed in pens that will accommodate several, if consideration is given to uniformity of age. It is not advisable to pen newly born calves together if there is an age spread of over three weeks. As the calves reach three weeks they can be placed with calves up to six weeks of age. Those from six weeks to nine weeks of age can be penned together. After calves reach the ninth week, there is not the same danger of spreading infection and a somewhat greater variation in ages is permissible.

Calf pens that accommodate several calves should have stanchions in which to confine the calves during and after the feeding of milk. This will prevent the calves from sucking one another. Poorly balanced and misshaped, as well as infected udders can result if calves are permitted to suck one another after being fed milk.

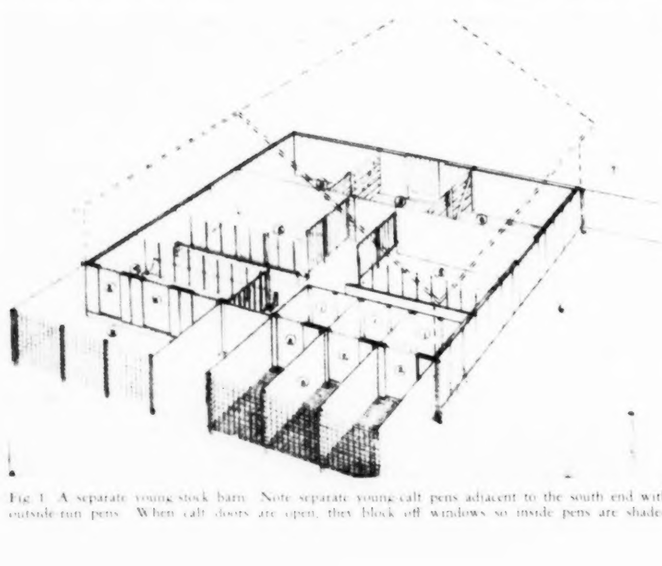

Fig. 1 A separate young-stock barn. Note separate young-calf pens adjacent to the south end with outside run pens. When calf doors are open, they block off windows so inside pens are shaded

Fig. 1 illustrates a cutaway perspective of a calf and young stock building designed by J. C. Wooley, agricultural engineer at the Missouri Agricultural Experiment Station. Such a building will adequately house the young stock produced in a 20 to 30-cow dairy herd, if calving is distributed throughout the year.

Three individual pens for baby calves are located in the south end of the building. Outside runs are available to each pen. These small runs should be kept free of vegetation to aid in the control of internal parasites. Infective larvae, of most of the small round worms of ruminants, establish themselves on vegetation and are ingested by the host while grazing.

Sliding doors can be raised in fair weather, permitting the calves to use the pens, thus providing space for exercise and exposure to sunshine. When the doors are up, they shield the windows which are immediately

above. This shades the inside pen, making it more comfortable in summer. Calves may be left in the individual pens for three to four weeks, depending on the calving schedule. Both inside pens and outside runs are built with solid partitions for maximum protection against drafts.

From the individual pen the calves may be moved at three weeks to the small group pen. This is also located at the south end and has an outside pen on the south side of the building. Small stanchions have been placed in this group pen for securing the calves during and following feeding.

The center part of the building has been designed for near yearling and older heifers that are being raised for replacements. These two pens can be made into one or separated as desired. Both pens open into lots on the sides of the building. The winter lot would be on the east side. During the summer the heifers would have access to a pasture on the west side.

Three maternity stalls have been placed in the north end of the building. They are separated from the calf and young stock part of the building by a solid partition that extends to the ceiling.

An effective and economical system of raising healthy dairy calves has been developed at the USDA Bureau of Animal Industry's regional animal disease research laboratory. This laboratory located at Auburn, Ala., is conducting research on bovine coccidiosis and internal parasites of cattle. Healthy parasite-free calves are needed for experimental use.

Portable individual pens 5 by 10 ft are used. The pens are constructed of a wooden frame to which is attached 1 x 4-in mesh welded woven wire 36 in high. One end of the pen is covered by a removable sheet aluminum top that is nailed to a light wooden frame. For added protection in cold weather, the covered end is enclosed by removable wooden panels. Heavy building paper can be substituted for the wooden panels. Burlap can be draped over the open end of the shelter in extremely cold weather. Each pen is equipped with a combination covered hay and grain rack and a water bucket that are suspended from the top rail. Bedding is used in the covered end.

An ideal location for a battery of these pens is on a shaded slope near the dairy barn. The pens are placed at the foot of the slope and moved up the slope in a zigzag manner, each pen being moved every seventh day. Thus each pen occupies a clean space each week. Two men can easily move the pen without disturbing the calf.

ADEQUATE HOUSING FOR ADULT COWS

The statement has been made (1)* that "Only healthy cows produce milk of good quality." Cows to be healthy must be free from injuries. Besides good quality milk, the dairyman is interested in high production. Top production cannot be attained unless the cows are healthy, free from injuries and completely comfortable.

Many injuries suffered by dairy cows are related either directly or indirectly to the inadequacy of the buildings and equipment. Such injuries generally do not affect the quality of the milk, from the standpoint of human consumption, as do various diseases such as brucellosis or tuberculosis. Mastitis, which often follows injury to the udder, may be an exception to this. Mastitis lowers production, causes difficulty in various manufacturing processes and makes the milk unpalatable and unsafe for human consumption. In advanced stages it causes milk to appear bloody, stringy or flaky, or thin and watery. In milder cases, although the appearance may not be changed, the milk may have a salty taste and an undesirable odor.

Udder injuries, stepped on teats, stiffness and lameness, injured knees and hocks, may all cause lags in milk production or may be severe enough to have a lasting effect on the animal. These can practically all be eliminated with adequate shelter and equipment.

The predominant cause of these injuries is inadequately designed and constructed stanchions and platforms in the conventional stanchion-type dairy barn. For the last fifty years or more dairy barns have been constructed with a nearly standard cow stall having a platform 38 to 44 in wide and 60 to 66 in long.

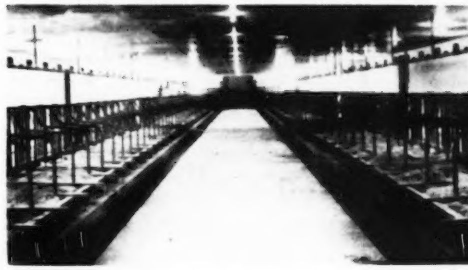

Fig. 2 Comfort-stall dairy barn in Connecticut. Note retainer curbs for bedding and the chain-tie stalls. Stalls are 4 x 6¼ ft. No swollen hocks, knees or udder injuries occurred during first winter

Very little thought has been given to the comfort of the individual cow in the past. Most dairy barns have been constructed with one standard length of stall platform, which is supposed to accommodate all the cows of one herd. No herd of milk cows, however, is of one uniform size and adaptable to one given length of platform.

From the standpoint of sanitation short or small cows are not adapted to long platforms, with the result that the litter is constantly wet and dirty. In moisture evaporation studies of dairy barn floor surfaces, in the psychroenergetic laboratory at Columbia, Mo.(2) it was found that the proportional amounts of evaporation from the bedding was from 9 to 13 per cent higher for Jerseys than for Holsteins when they were both confined in standard 48 x 68-in stalls. This indicates that the Jersey, being a shorter and smaller cow, and not adapted to this standard platform length, deposited a higher proportion of urine and feces on the bedding. This situation causes dirty cows and unsanitary conditions in general. More bedding and more labor are required to maintain any degree of sanitation. Milk-sediment tests and bacteria counts will also generally indicate undesirable conditions.

The concrete platforms of these conventionally designed cow stalls are particularly uncomfortable in themselves. They are hard and cold due to the nature of concrete. The flat smooth design of the platform, with some slope to the gutter for drainage, makes it quite difficult to keep it adequately bedded. Cold floors are conducive to mastitis and lameness. The udder, if directly in contact with cold concrete, is exposed to chilling as well as to drafts and to injury by adjacent cows. Even though the platforms are long enough, observations show that in many cases the cow must lie in an awkward position which leaves the udder unnaturally exposed.

Much consideration has been given to the adaptation of the cow to a given platform and stanchion. Various types of trainers and gadgets have been devised to train cows not to stand in the gutter, although from a comfort standpoint that must be the natural place for her to stand. A fairly successful electric trainer has been developed at the University of Wisconsin, which makes long platforms more sanitary by causing the cow to deposit its fecal matter and urine back farther. Spacers have been devised to keep the cows from crowding and injuring one another. These methods have been attempted cures without actually diagnosing the basic cause of the trouble. At best it is asking quite a bit of a cow, with the best designed platform and gutter, to at all times deposit the fecal matter and urine directly into the gutter, not on the stall platform nor on the alley floor behind, and never to stand in the gutter nor hang over into it when lying down. It is the authors' contention that new shelter and equipment should be adjustable and adaptable to the cow rather than later attempting to fit the cow to the equipment which has been constructed in a non-flexible manner.

If dairy cows are to be confined in stanchion-type barns, everything possible should be done to make the cows com-

*Numbers in parentheses refer to the appended references.

fortable and to keep them free from injuries. The so-called comfort stall has been successfully used in many instances. Fig. 2 shows the interior of a comfort stall dairy barn on the Wood Ford Farm in Connecticut. Note the 4-in retainer curbs for the bedding. The stalls are 48 x 75 in and the rear retainer curb is adjustable to the individual cows. The floors are insulated and the curbs retain a thick dry litter under the cows. Chain-tie stalls are used for maximum freedom. This allows the cows to move forward in lying down and so be completely on the curbed portion of the platform. In this 100-cow herd no swollen hocks or knees or udder injuries were reported during the first year the equipment was used.

J. C. Nageotte of Pennsylvania State College has designed a somewhat more elaborate comfort stall. It has the retainer curb for litter which is adjustable fore and aft. Pipe partitions extend back within 16 in of the gutter between each cow. It has a chain tie. The grain and hay mangers are suspended on rods projecting from the stall partitions making them also adjustable fore and aft.

It should be remembered that any added equipment to the conventional stanchion-type barn increases the already high housing investment for the dairy herd. The majority of dairy farmers are interested in an economical, functional and simplified type of housing for their dairy enterprise. Loose housing fills these requirements besides being very advantageous from the standpoint of general animal health and in the elimination of injuries.

A summary on herd health at the University of Wisconsin in connection with the research project on comparative results of the stanchion barn versus open loose-housing barn reports that the number of cows affected by stiffness and lameness, injured knees and hocks, and stepped on teats amounted to forty in the conventional stanchion barn against none in the uninsulated loose housing barn. Seventeen of the cases caused noticeable production lags and twelve were considered to be injuries having a lasting effect on the animals.

Similar observations were made at a research project (4) in Idaho at the Caldwell Branch Station. In this study 18 paired cows were observed, nine in the stanchion barn and nine in the open shed. Cases of injuries, stiffness, bruised knees and hocks, and cows off feed occurred almost seven times more often in the stanchion-barn group than in the open-shed group for the two winters of 1948 to 1950. The cases in the stanchion barn were thirty-four as compared to five in the open shed. In observing sanitation conditions they also found that cows on concrete surfaced lots produced milk with less sediment by a significant amount and their udders were significantly cleaner than cows in unsurfaced lots or in the stanchion barn.

With the loose-housing system there are certain requirements that must be met as is true with any system. One of the most important of these is adequate space. Utah State Agricultural College (5) found that for Holstein cows shed area of 40 sq ft per cow was inadequate and 75 sq ft was more than necessary. Three per cent more bedding was required for the 40 sq ft allotment per cow and they were not as clean as those using less bedding in the larger area. During the experiment four quarters were treated for mastitis when the cows were restricted to 40 sq ft. No mastitis developed when the allotment was 75 sq ft.

SUMMARY

These results, from controlled experiments as well as many field observations, show that loose housing, if managed properly, reduces injuries to a minimum and maintains the over-all herd health at a high level. As with any other system, however, certain requirements must be fulfilled, such as adequate space, proper bedding, and, most important, good management in general which in the final analysis will make or break almost any system.

If stall barns are to be used, and they will always have a place in some climates and with some operators, much can be done to improve the comfort of the cows and general sanitation. Wider stalls with adjustable lengths are desirable, or versions of the so-called comfort stall may be used. Chain-tie stalls which allow more fore-and-aft movement have been found advantageous.

In general, housing of dairy cows and calves is important in producing and maintaining healthy individuals that make up the herd. This is largely the result of demands for rapid development and heavy production that are made on dairy breeds. For a successful dairy-building program, consideration must be given to location, ease of cleaning, arrangement, cost of materials and cost of construction to provide sanitation and comfort. Only healthy cows maintained in such surroundings will produce high quality and wholesome milk for human consumption.

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Design of Baled-Hay Driers

(Continued from page 651)

7 The height of the air opening on each side of a center main duct is determined by the formula $W = Q \times (0.006/L)$. For a side main air duct, use the formula $W = Q \times (0.012/L)$, where W = width of crack in inches, Q = cfm of air the fan is rated to deliver against ¾ in of static pressure, and L = length of air opening along one side of main duct in feet.

8 The air-intake opening to the fan should be large enough so that the air velocity through it will not exceed 1,000 fpm. There should be at least 1 sq ft of ventilation area above the drier for each 200 cfm of air delivered by the fan.

9 The hay should be cut at the proper stage of maturity and allowed to dry in the field to about 35 to 40 per cent moisture (just before leaves begin to shatter) before baling. Loose bales about 30 to 36 in long are desirable. The bales should then be moved to the drier and stacked tightly together. Place the cut edge of the bale toward the air and break the joints between succeeding layers as much as possible.

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Engineering Phases of Dairy Barn Research, 1941-1951

By S. A. Witzel and D. W. Derber
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ON OCTOBER 28, 1940, the University of Wisconsin and the United States Steel Company entered into an agreement which inaugurated the Wisconsin Dairy Barn Research Project. Plans for the physical plant were prepared and contracts were let for construction to start early in the spring of 1941. On October 1, 1941, the first six-month winter test period was started. The project was set up to compare the performance of high-producing herds under different housing and management conditions over a ten-year period.

Responsibility for direction of the project was vested in University departments interested in dairy-cattle housing. Two staff members served as co-chairmen of the project. They were E. E. Heizer of the dairy husbandry department and S. A. Witzel of the agricultural engineering department. An informal committee representing these and several other University departments was established for consultation, and, as it later developed, for direct participation in the project.

The project was carried on in a housing facility developed especially to satisfy the basic objectives of the research. The actual work on the project was divided between the interested departments. The dairy science phases of the project are being reported by E. E. Heizer and his associates for publication in the *Journal of Dairy Science*. Detailed information on herd selection, herd management and all phases of herd performance on this project may be found in their report.

A project engineer maintained an office at the barns where he made routine observations, kept up the physical plant, conducted visitors through the barns, collected data, made summaries, and prepared reports.

OBJECTIVES OF THE PROJECT

The Wisconsin Dairy Barn Research Project was established to compare loose housing of dairy cattle with conventional stanchion-barn housing. The original objectives plus those which were added as the study was carried forward are as follows:

1 Minimum requirements for proper housing
2 Efficient arrangement, design and management
3 Quality and quantity of milk
4 General health of animals
5 Feed requirements
6 Labor requirements
7 Bedding requirements
8 Temperature, humidity and condensation conditions
9 Means of improving dairy structures
10 Application and serviceability of steel to dairy structures
11 Loose housing under warm and cold conditions
12 Influence of loose-housing management on fly population

It was decided that herds of seventeen cows each would be used. For the stanchion barn (A barn), an insulated, one-story steel structure was erected. This barn was designed and operated in accord with good management standards advocated for a conventional stanchion barn. The loose-housing barn (C barn) was operated as a cold barn where the cows could go through an open door to the outside whenever they chose. While loose housing was not new, there were a number of factors affecting design and arrangement which required detailed study. Comparative performance of high-producing cows under loose-housing conditions in this climate and under present-day milk-quality standards had not been studied. It was anticipated that the study would show opportunity for a considerable number of adjustments in design and management which would increase the efficiency of loose-housing systems under our climatic conditions. In fact, it soon became apparent that a third herd housed in a second loose-housing barn would be necessary to secure essential data. This was known as the B herd and it was housed in B barn as soon as the additional unit could be provided.

Barn B was an insulated, warm barn for confined loose housing. This permitted comparisons of warm, loose housing with warm housing in stanchions, and of cold, loose housing with warm, loose housing. After three years of operation as a warm barn, B barn was opened up and operated as a cold, open barn. The C herd was housed in an open, uninsulated, cold loose-housing barn for the entire duration of the project.

With the aid of funds from the USDA Research and Marketing Act, the state agricultural experiment stations in the north central region, in 1947, initiated a cooperative research program on farm buildings. The Wisconsin station set up a project on the improvement of milking parlors with the aid of these funds. The Dairy Barn Research Project facilities were used in this regional study.

THE PHYSICAL PLANT

The original physical plant of the Dairy Barn Research Project utilized prefabricated steel structures. These one-story, fire-resistant buildings were still further safeguarded against extensive fire damage by locating the hay and bedding storage building away from the animal-housing barns. All of the experimental herds were fed from the same supplies of roughage and concentrates.

The original layout consisted of the following major building units:

1 The stanchion barn, 37 ft wide and 60 ft long, contained 15 stanchion stalls, two calf pens and two pens for cows. It was insulated, ventilated, well lighted, and the A herd of 17

A report on the engineering phases of a cooperative research project between the University of Wisconsin and the United States Steel Company, and supported in part by regional funds under the U.S. Department of Agriculture Research and Marketing Act of 1946. Released for first publication in AGRICULTURAL ENGINEERING.

The authors: S. A. WITZEL and D. W. DERBER, respectively, professor of and research associate in agricultural engineering, University of Wisconsin.

Fig. 1 (*Left*) The Wisconsin Dairy Barn Research Project facilities included the two loose-housing barns on the left, the stanchion barn on the right, and the feed-storage units in the center • (*Right*) The two experimental herds from the loose-housing barns enjoying winter sunshine with an outside air temperature of —15 F zero when this picture was taken

cows had what was considered generous-sized stalls. The stalls were 3 ft, 10 in wide, with full-length concrete curbs between stalls, and they were from 5 ft, 2 in to 5 ft, 6 in long. No two cows could be permanently assigned to the cow pens because pen space had to be made available when any of the cows needed relief from their stanchion stalls, such as at calving time. The roof was supported by trusses, so columns were eliminated. This barn, housing the control herd, remained essentially as originally constructed throughout the ten-year period.

2 The milking parlor, hospital room and weigh room were housed in a 24-ft extension of the stanchion-barn structure. The original milking parlor, 24 ft by 24 ft, was of floor-level type with four stalls for milking. The weigh room contained a bullock scales, vacuum pump, and tool cabinet. The hospital room had a sink, storage cabinets and a restraining stall.

3 The original loose-housing barn was an L shaped structure 25 ft wide and 76 ft long, with a wing to the south 28 ft long. It was constructed with single sidewall and roof sheets of galvanized steel, and there were four outside doors 8 ft or more in width. Ample steel sash for windows were used for light and ventilation. Three roof ventilators, 18 in in diameter, and having revolving heads, were set on the ridges. The barn was operated with at least one large door completely open at all times.

The loose-housing barn (C barn) was equipped with two calf pens, two cow pens, a feed alley and a feed manger. It provided approximately 100 sq ft of space per cow, which included the bedded area and the feeding area. The floors were of sandy fill material that did not pack well. An insulated water tank was provided in the feeding area.

4 The milkhouse and office building, 24 ft by 36 ft, was of steel-pan construction throughout, with smooth interior and exterior walls, batt-type insulation and a flat, built-up roof.

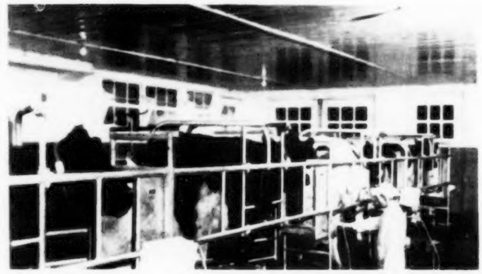

Fig. 2 The elevated milking parlor with pipe-line milking machine mechanizes the milking operation for loose-housing herds. Labor requirements were reduced by one-third with this equipment

The east section, 13 ft by 24 ft, of this building was used for the utensil and the milk cooling rooms. The west section of the building contained an office, a bedroom, a washroom, complete with shower, a furnace room, and corridors. This building proved entirely satisfactory, and aside from changes in water-heating equipment, milk-cooling equipment and can storage, remains the same as originally constructed.

5 The hay-storage structure was 36 ft by 48 ft by 12 ft, setting on a concrete-pier foundation. Curtain walls between piers, of 16 gauge corrugated sheets 7 ft long, placed horizontally, were satisfactory for completing foundation enclosure. Large hay-barn doors provided access to ground-level storage by fully loaded trucks or wagons for quick unloading.

6 The hay keeper, 18 ft by 26 ft, was used two years. The

Fig. 3 Original plant consisted of housing for two herds of 17 cows each. The loose-housing C herd was milked in a 4-stall floor-level milking parlor, while the stanchion A herd was milked in the stanchion barn

storage capacity of this structure was relatively small as compared to the needs of the herd, and it was not convenient to refill after the haying season was over. The practice of feeding baled hay was followed. This was purchased as needed throughout the season.

7 The silo was a commercial galvanized sheet-iron structure, 14 ft by 32 ft, equipped with drain and treated on the interior with a series of test panels painted with different types of interior paints for silos. None of these treatments proved to be of permanent value in preventing corrosion.

8 A government specification type of steel grain bin, 10 ft by 14 ft, was erected to serve as a storage for grain concentrates. While the structure was no doubt satisfactory as an ever-normal granary, it was soon found necessary to move the narrow door to the outside for truck unloading of sacked feed, while a much wider opening to the covered passage was cut in the bin so the feed cart could be taken in for filling.

9 An enclosed passageway was provided between the hay, silage and concentrate storage and the three experimental barns. Another such passage, but of insulated construction, was placed between the milkhouse and the barns.

10 Cattle yards were fenced with 39-in woven-wire fencing, having No. 9 wires top and bottom and No. 11 wires between. It was placed on 6-ft T-type steel posts set 12 ft apart, and driven steel corner posts were used.

11 The barn lots, of about 500 sq ft per cow, contained about 200 sq ft of area per cow that was graded for drainage, and graveled with road-bound gravel.

ADJUSTMENTS IN THE PHYSICAL PLANT AND EQUIPMENT

The stanchion barn was of advanced design when constructed. All available information was used in planning an arrangement for loose housing that would be practical for this climate. Since the stanchion barn (A barn) was to act as a check or standard for comparison with the loose-housing systems, only a few minor changes were made in it over the 10-year period.

A record of changes and improvements made in the physical plant and equipment for the loose-housing system are essential in this report. They have been responsible for the continually increasing efficiency of operation of the loose-housing barns over the 10-year period.

ALTERATIONS AND IMPROVEMENTS

1941-42. The milking panel of four stanchions spaced 3 ft apart in the floor-level milking parlor were too crowded for the operator to do the milking properly. Alternate stalls were increased to 4 ft 6 in in width by lengthening the panel 18 in at each of these two points.

The steel feed boxes hung on the milking panel 18 in above the floor were replaced with a design planned to minimize the amount of feed wasted.

In the feeding area, 10 ft between manger and wall, used also for a holding area just outside the milking parlor, the manure pack was soft, wet and soiled even when bedded twice a day. It was not possible to keep cows from lying down there. Some cows were found nearly every milking which were difficult to clean, and occasional high bacteria counts in the milk were recorded. This situation required correcting. The final solution, worked out through the second and third test periods, was to provide a smooth, paved feeding area that could be cleaned daily. The use of a clean, paved feeding area resulted in a cleaner bedded area, cleaner milking parlor, cleaner cows and greatly improved milk quality. This improvement had proven to be a "must" for the production of high-quality milk

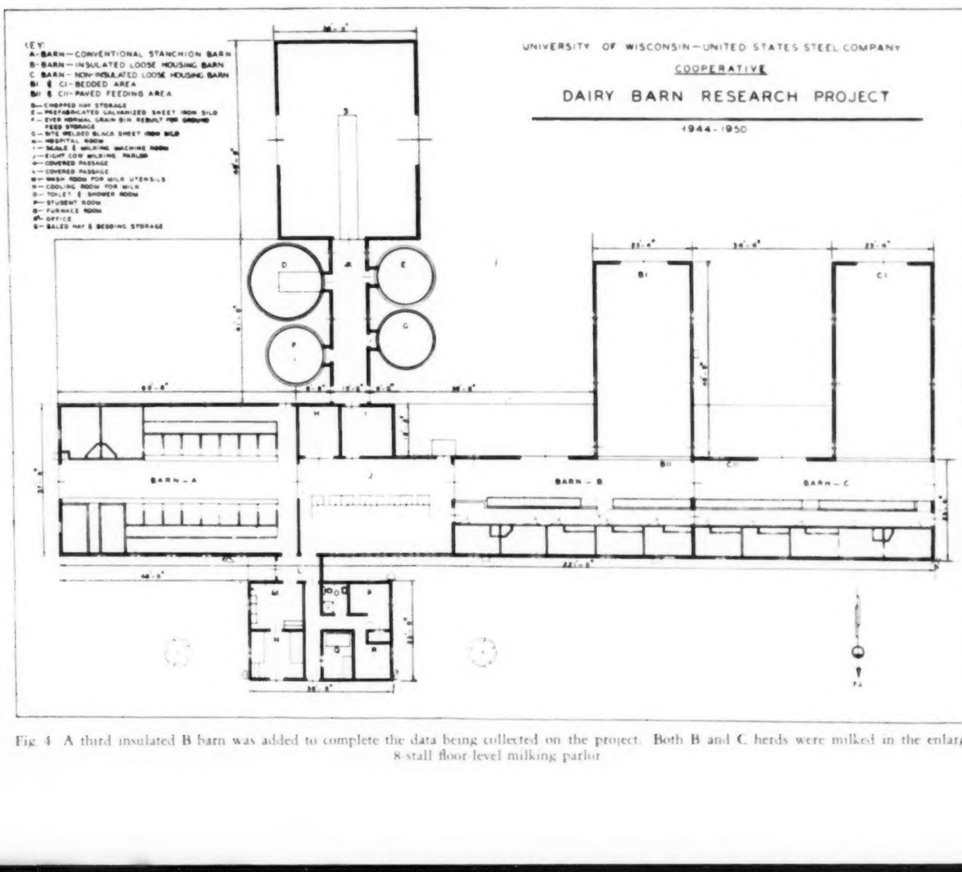

Fig. 4 A third insulated B barn was added to complete the data being collected on the project. Both B and C herds were milked in the enlarged 8-stall floor-level milking parlor

in the loose-housing system. It also reduced the previous large requirement for fresh bedding every day. This also proved to be an effective way of preventing cows from tracking straw into the milking parlor.

1942-43. This year the bedded area came in for some consideration, partly by accident. About the middle of the winter the manure was removed from most of the bedded area during a period of mild weather. In the sudden, prolonged cold weather which followed, the cows crowded onto the remaining manure pack in a small part of the bedded area. Temperature readings indicated a manure pack temperature of between 80 and 100 F, while ground temperatures in the cleaned area were about 65 F. This and later observations led to the conclusion that the manure pack would be of greatest benefit if it remained undisturbed throughout the cold part of the housing season.

1944-45. This was a period of considerable building activity. The four-stall milking parlor was increased to an eight-stall floor-level plan to make two-man operation more efficient. Six cows instead of two could be changed and fed at a time, thus saving time and travel for the operators. This gave the cows more time to eat their concentrate ration which was fed in the milking parlor.

A third test barn to be operated as a closed, warm loose-housing barn was considered desirable to determine the effect of warm, loose housing on herd performance. This insulated steel barn was provided and designated as B barn.

Site welding was developed as a means of building farm structures of steel without prefabrication in a shop. This type of construction was designed and complete time studies on erection were made. These data were reported in an article in AGRICULTURAL ENGINEERING (vol. 27, October, 1945).

The original yard fence had sagged, posts had bent, and in general its appearance was not good, even though it still held the cows. A new fence of 47 in high, all No. 9 wire, was used in the new yard fence. Corner posts were set in concrete. Heavy U-type steel fence posts, 7 ft long were placed 10 ft apart. This made a substantial fence that at present looks good after seven years of use.

The gravel in the barn lots required cleaning by scraping off soft areas and regraveling. It was obvious that gravel was not satisfactory for a clean barnyard when used by the dairy herd under all weather conditions.

A large-capacity gun-type oil-burning hot-water heater was installed to provide ample hot water at a uniform temperature for all cleaning operations.

1945-46. A site-welded black-sheet steel silo, 14 ft by 36 ft, was built as a part of the site-welding development. The lap-weld construction for a cylinder of uniform diameter proved difficult to fabricate because the sheets had to be shaped in order to be forced into position, and maintain the same diameter from top to bottom. No doubt a butt-welded job would have been less troublesome. A satisfactory silo was erected in a very short time from what appeared to be a small pile of 3/16-in and 1/8-in steel sheets 4 ft by 8 ft in size.

1946-47. No important changes were made except that the pavement in A barn lot was extended past the hay barn doors to make a larger lot for the cattle, and to make the hay barn accessible to trucks at all times. Plans were formulated for a project on milking-parlor studies.

1947-48. A regional project on milking-parlor research supplied part of the funds required to set up a milking-parlor laboratory for operation during the summer period when the entire herd of 50 or more cows was available for the study.

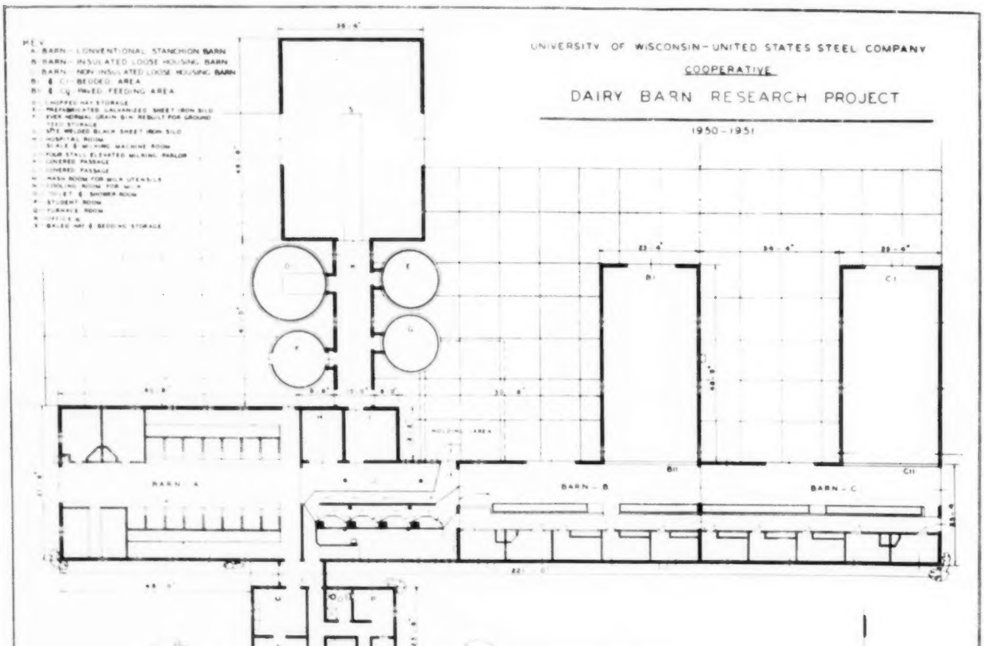

Fig. 5 Following three years of milking parlor research, a 4-stall elevated tandem milking parlor complete with pipeline milker, bulk-milk cooling tank and bulk-milk delivery was placed in operation

The results of these studies are available from the reference literature appended to this report.

This was the year B barn was abandoned as a warm, loose-housing barn. Sufficient evidence had indicated that warm, loose housing was not satisfactory.

1948-49. The barn lots for B and C barns were paved. This provided a paved area of 175 sq ft per cow. An area of about twice this amount remained unpaved in each lot.

The double door in the end of A barn was replaced with a new steel skin-stressed set of doors, having a fiber flap covering the lower four inches of the opening.

1949-50. The bedded area in C barn was paved to facilitate cleaning. The original fill was sandy and rutted easily.

In preparation for the last test period, the milking parlor was completely remodeled to provide an elevated, four-stall, tandem arrangement, incorporating ideas gained from experience in the milking-parlor laboratory. The design was also adapted to the barn and the space available. Provisions were made to accommodate visitors interested in observing directly from the operator's level.

The new equipment included a milking machine with supported milker claw, pipe line for milk, refrigerated storage tank for bulk milk, and an insulated tank trailer for delivery to the plant. A water softener was installed to aid in the control of deposits on milking equipment.

1950-51. The tenth period completed the project. A hot-water unit heater was installed in the milking parlor to provide comfortable temperatures for the milking operation. A chemical feeder was developed for the warm-water wash line in the milking parlor. This provided a fresh sanitizing solution at each milking stall for washing udders and flushing teat cups.

WARM LOOSE HOUSING

After three seasons of use, B barn, which had been operated as a warm, loose-housing barn, was opened up and operated as a cold barn for the last four test periods. This change was made because the operation of a warm, loose-housing barn was unsatisfactory, for the following reasons:

1 The accumulation of moisture in B barn coming from the herd of cattle and the deep manure pack made satisfactory ventilation difficult. In fact, condensation occurred on the insulated ceiling and sidewalls when the windows were closed to keep the barn warm. In cold weather, dampness was extremely annoying, paint became discolored, bedding was soggy, more bedding was used, cows were not as clean and the cattle did not eat their feed as readily as C herd.

2 Odors were noticeably bad in B barn as compared to A barn. Except for a day or two at cleanout time, the open C barn was always free of odors; in fact, except for when fresh silage was being fed, C barn had no barn odors that could be noticed.

3 Daily cleanout of B barn bedded area was rejected as a possible solution to the air conditions in B barn because of the large amount of bedding required the first few weeks during which a manure pack was being started.

4 Cows were being denied the beneficial effect of exercise, sunshine and fresh air as B herd was turned out only as A herd was turned into the lot.

FEEDING ARRANGEMENTS

Batch feeding gave every cow a chance to get her share of fresh roughage at each feeding. There was no difficulty from boss cows. Since all roughages had to come from a common supply for the trials, carts were used to haul silage and baled

SUMMARY OF PROJECT DATA

Test Period	1 1941-42	2 1942-43	3 1943-44	4 1944-45	5 1945-46	6 1946-47	7 1947-48	8 1948-49	9 1949-50	10 1950-51	
Dates	Oct. 1 Mar. 31	Oct. 12 Apr. 11	Oct. 12 Apr. 11	Jan. 31 Apr. 11	Nov. 14 May 1	Nov. 1 May 1	Nov. 4 Apr. 19	Oct. 15 Apr. 14	Oct. 25 Apr. 24	Oct. 17 Apr. 16	Avg. of last five test periods
No. of days	182	182	183	70	168	182	168	182	182	182	
Temperature, deg F											
A barn	67.5	49.5	49.1	53.6	52.8	51.4	56.4	52.3	54.0	56.7	52.9
B barn, warm				54.1	49.3	51.1					50.9
B barn, cold							42.2	45.7	45.7	38.2	42.9
C barn	46.7	36.0	35.2	43.0	39.0	38.0	34.8	37.3	36.7	29.6	36.1
Outside	42.5	28.8	30.1	34.3	30.8	31.4	34.4	31.7	29.5	26.7	30.5
Per cent relative humidity											
A barn						79.20	86.87	79.37	85.15	76.24	81.37
B barn						76.16	84.61	81.46	73.68	67.39	76.66
C barn						79.59	82.44	78.63	71.10	62.66	74.88
Outside						73.32	77.32	71.01	65.36	60.86	69.57
Vapor pressure millimeters of mercury											
A barn						7.6	9.9	9.6	9.0	9.0	9.02
B barn						7.4	5.8	6.3	5.7	3.9	5.82
C barn						4.6	4.2	4.5	3.9	2.5	3.94
Outside						3.3	2.5	3.2	2.6	2.1	2.74
Floor temperature, deg F (stall barn, average of all readings)											
Outside air								31.3	31.1	29.4	30.6
Inside air								58.8	53.9	63.1	58.6
North stall								59.8	60.8	66.2	62.3
South stall								59.8	62.8	64.4	62.7
Manure pack temp., deg F (average of all readings, 9 stations)											
B barn						86.7	81.9	87.9	95.5	75.4	
C barn						80.8	82.3	86.6	93.9	64.4	
Pounds of bedding per cow per day											
A barn											
B barn						14.6	13.2	10.6	16.3	9.6	
C barn						11.9	12.6	10.1	16.0	8.4	
Time required, man-hours per day per herd											
A barn, per cent					100	100	100	100	100	100	
B barn, per cent					88.67	88.34	86.04	92.39	90.91	65.00	
C barn, per cent					90.34	88.26	83.69	91.28	87.86	66.97	

hay as well as baled straw for bedding. Under such an arrangement batch feeding, all at one manger, was a satisfactory arrangement. For dairy farmers interested in self-feeding arrangements or one-time-a-day feeding, separate mangers for hay and silage may be a better arrangement and actually require less space.

A deep feed manger was developed somewhat similar to the efficient western feeding fence which prevented the wasting of hay. Besides eliminating the waste of hay, this manger kept litter off the paved feeding area and in turn discouraged the cows from lying here. The trials have shown that cows can be maintained as clean under loose-housing conditions as under carefully managed and favorable stanchion-barn conditions. Only by maintaining an open, clean bedded area and by cleaning the paved feeding area daily, except when frozen solid, was this possible. This practice also served to keep litter out of the milking parlor.

LABOR COMPARISONS

Time studies were made each winter at the project. The first four winters these time studies were used mainly as a basis for improving the management, equipment, barn design and labor efficiency of the loose-housing system.

The comparative labor requirements were determined by time-study methods with one observer per laborer. The time, taken by a stop watch, was recorded generally to the nearest five seconds. These data were then tabulated to determine the total time required for each operation. The time studies were taken for five consecutive days for each test period from 1945-46 to 1950-51.

All the labor was done by the regular project workers during the time-study period. The table on test data lists the comparative time in per cent required for each barn covering the last six test periods. The total time involved for handling the loose-housing herds was consistently less than the total time necessary in handling the A barn herds.

In any labor comparison study, the item of fatigue of the worker is an important element in the comparison. No accurate, simple means has been devised to measure this fatigue. The chore operations used in an elevated-stall milking parlor differ from the necessary stooping involved in milking, as well as carrying of milk, that are required in a stanchion barn. The assembling of a milk pump and pipe line for loading milk also differs from the kind of work and fatigue involved in handling 10-gal cans of milk.

For the tenth winter test period, labor comparisons indicate a labor saving of 35 and 35 per cent in B and C barns, respectively, over A barn labor requirements. This saving of labor in the loose-housing barns was greater the tenth year than it was in any previous test period. The use of the elevated-stall milking parlor, pipe-line milker and slightly different management of the loose-housing herds may account for this difference.

MANURE REMOVAL

Clean cows, one of the requirements for the production of clean milk, can be maintained under loose housing when it is arranged and managed properly. A cold, open-bedded area having a warm, firm manure pack can be kept clean with a minimum amount of bedding if the droppings are turned under or placed along the unused edges of the manure pack once or twice a day. By changing to this practice in the tenth test period, only 10 per cent more bedding was used in C barn than was required in A barn. For bedding requirements and stall-floor temperatures see the accompanying table giving a summary of test data.

A crew of three men cleaned, hauled and spread all the manure from the bedded area of the loose-housing barn, that had accumulated through the winter-housing season, in eight hours. Had the calf and cow pens been located and constructed for cleaning with the tractor loader, possibly along one side of the bedded area, no doubt the hand work could have been saved. All housing and feeding space should be accessible and have sufficient head room for cleaning with a tractor-mounted fork.

The scrapings from the combined feeding and holding area were removed daily and hauled to the field with the manure from the stanchion barn. All of this manure handling was by hand. A barn cleaner could have been installed in the stanchion barn and a tractor scraper and loader could have been used to clean the feeding areas in B and C barns.

For convenience on a dairy farm, the feeding area should be arranged for scraping or loading into a manure spreader or manure pit outside the cattle yard. If this manure pit can also be located for receiving barn-lot scrapings, there would be considerable advantage in having such an arrangement. This would make daily hauling of manure unnecessary, as the volume of scrapings from the feeding area would not make a load more than about twice a week for a herd of 25 cows. The manure pit would serve to absorb the large amount of barn-lot scrapings after thawing out in the spring, and it would serve to hold the manure over until the fields were in condition for hauling and spreading.

WASTE DISPOSAL

Drainage from the milk room and milking parlor has been through a concrete settling tank approximately 3 x 8 x 10 ft deep. This tank extends to the top of the ground and has removable concrete slabs for the top. The effluent was disposed of through a seepage well and leaching system. Early in the study, the cows were found to waste feed enough to fill up the settling tank rapidly. A redesign of feed mangers in the milking parlor so the cow was forced to keep her mouth over the manger reduced the waste. Cleaning by pumping or bailing out the settling tank once a year has been adequate. By using grills with drains in the rear of each stall, splash was

WEATHER DATA SUMMARY

(Compiled from reports of U. S. Weather Bureau Stations at Madison, Wis.)

	1941-42	1942-43	1943-44	1944-45	1945-46	1946-47	1947-48	1948-49	1949-50	1950-51	10-year summary	Normal
Temperature, deg F												
Maximum	86.0	77.0	78.0	78.0	80.0	81.0	85.0	77.0	83.0	82.0	86.0	
Minimum	[illegible]	-10.0	- 6.0	-13.0	-12.0	-17.0	-17.0	-19.0	-10.0	-37.0	-37.0	
Daily mean	36.09	[illegible]	32.93	34.1[illegible]	34.22	33.58	32.64	33.20	32.11	29.62	32.94	31.44
Total Precipitation, in	9.81	13.37	12.38	11.16	11.09	13.33	13.71	13.28	16.69	13.93	12.58	13.56
Snow fall, in	27.6	[illegible]	23.0	36.6	45.7	37.7	50.5	32.2	36.5	59.1	43.2	37.4
Wind velocity, mph												
Average	9.04	9.66	8.73	8.67	9.14	1[illegible].75	10.65	11.98	13.58	12.91	10.51	
Highest	[illegible]	[illegible]	[illegible]	32.0	40.0	54.0	47.0	[illegible]	65.0	43.0	65.0	
Sunshine, per cent possible	40.0	[illegible]	44.7	36.3	46.4	51.4	51.5	50.5	50.7	43.8	46.9	46.0
Snow cover												
Duration, days	[illegible]	[illegible]	60	90	120	125	150	120	13[illegible]	130	113.5	
Max. depth, in	[illegible]	[illegible]	[illegible]	13.[illegible]	[illegible]	13.6	8.3	1[illegible].1	11.0	17.0	17.[illegible]	

largely eliminated and milking-parlor floors could be kept clean during milking.

A separate septic tank was installed for the domestic sewage. The effluent was disposed of through the same leaching system used for the rest of the drainage for the milkhouse and milking parlor.

TEMPERATURE AND HUMIDITY

The accompanying table summarizing the test data shows the average temperature as well as maximum and minimum for each of the barns and outdoors. Since no correlation between production and temperature changes could be found, these data serve only to indicate the conditions under which the tests were conducted. It should be noted that C barn maintained from six to ten degrees higher temperature than outside in all cold weather. It is also interesting to note that, while the relative humidity in C barn was not too much less than in A barn, the vapor pressure measured in millimeters of mercury registered a wide variation, as follows: A, 9.02; B, 5.82; C, 3.94; and outside, 2.74.

SERVICEABILITY OF STEEL STRUCTURES

One of the purposes in establishing the Wisconsin Dairy Barn Research Project was to study the adaptability and performance of steel structures and equipment when used in dairy-cattle housing. After ten years of use, the exterior galvanized sheets present a good appearance with no evidence of corrosion except for perhaps a half-dozen isolated sheets which, upon close examination, are starting to show brown stain, but no noticeable rust spots. There are also a few bolts on the exterior that were not well galvanized and are showing rust which tends to stain the sheet. No exterior maintenance work has been performed on these buildings, except for a few repairs to the doors. The exterior walls and roof of all buildings have now been painted and appear to have almost the utility of a new building.

The painted surfaces of the interior make a dairy structure that can be kept clean and sanitary. Little evidence of corrosion has been found on the interior of the barns, whether these surfaces be of galvanized sheet steel or exposed structural steel framing and trusses.

The interior of the two steel silos, one made of galvanized steel sheets that were painted at the time of erection ten years ago, and the other made of black sheets welded on the site six years ago and placed into service without painting, are both showing rust-covered surfaces but no evidence of deep pitting. Another ten years or longer will be required to determine how effectively the silos resist further corrosion or deep pitting.

The milkhouse and office structure, which was of pan construction made from heavy zinc-coated sheets, has been a very serviceable building. No sign of corrosion on the exterior or interior is evident except for a few spots on the painted black steel sash.

Doors in the barns have demonstrated the need for improved design to overcome some minor difficulties. A hinged barn door needs strength, and to secure this strength, the skin covering should be an integral part of the structural framework of the door. To accomplish this, it is possible to weld heavy-gauge steel sheets to an adequate steel framework. These doors should be equipped with strong and serviceable hardware that works easily in all kinds of weather. To protect the bottom of the doors, and to obtain full closure regardless of frost or ice condition, a heavy rubber-covered webbing or belting can be used on the bottoms of the doors.

Outside operating doors, that must be located on the eave side of the building, need ample clearance. In years of deep snow, a ground clearance of 6 to 12 in or more is desirable, and even then some scraping and picking may be necessary. This indicates the need for exploring methods of door location and design to minimize such operating hazards. In the loose-housing type of construction, it is better to have doors that function than it is to have doors that fit tight. In cases of extreme cold, one can easily set a board in behind the doors or place a few bales of straw along the bottom to prevent an unwanted draft.

It can be assumed that the structures are just as strong and serviceable at present as they were immediately after erection. The lack of structural weakness, significant deterioration, or corrosion, are evidence in support of this conclusion. Because the buildings were constructed on and well anchored to a firm concrete foundation extending well above manure level at all points, no sagging or other structural weakness has developed.

The clear-span buildings have made possible numerous relatively inexpensive changes in the interior design of the buildings. A practical design for loose housing of cattle has been developed which involves a minimum of expense and inconvenience.

For the stanchion barn, the free-span construction made a smooth low ceiling possible. Columns, so frequently a problem in causing injuries to cows, were eliminated.

Site-welded construction, as developed in response to the need for a suitable loose-housing structure at the project, was used in the erection of C barn. A range of steel barn sizes in width and length are today available at prices comparable to simple wood structures. From present indications, the site-welded steel building, set on a foundation well above the level of manure accumulations, would have a lower maintenance cost than wood, and might be expected to provide a long service life.

In both types of dairy-cattle housing structures, there is moisture condensation at certain times. This is especially true in the stanchion barn where the capacity of the ventilating system is not adequate for the warmer days in the winter. Some operators have opened windows to relieve this condition, but unfortunately the 40-hr, five-day week of the University employees makes manual control difficult. It is not always convenient to be in the barn when the windows need opening and closing. If additional insulation were provided to raise the dew point of the interior surfaces, it would also help solve the condensation problem. The greatest objection to this condensation has been appearance. Moist walls collect dust, support mold growth, and soon become grimy and discolored. A thorough washing is then needed to restore the clean finish. The condensation that occurred in the cold, loose-housing barn usually followed extremely cold nights. This condensation usually disappeared rapidly and did not appear to be objectionable except for its effect on wall finish.

It was noted that steel surfaces provide an excellent moisture barrier when the joints are tight. Likewise, steel does not absorb moisture, but it can collect condensed water vapor on its surface. Good ventilation will remove this condensation. In fact, good air movement within the barn will prevent its formation in the first place.

In the insulated buildings the insulation, within the walls and on the ceiling, is bright and shows no evidence of moisture.

The barn lot fence of 47-in, No. 9 woven wire, fastened to heavy 7-ft steel posts and secured to braced steel corner posts set in concrete, has proven adequate for the severe service it must withstand.

A 4-in reinforced concrete slab was placed over a 4-in sand fill in B and and C barn lots. The reinforcing consisted of 6-in by 6-in No. 6 welded wire fabric placed in the center of the slab. This reinforced slab made of good quality concrete provided an inexpensive, sanitary and convenient barn lot surface when no weights heavier than farm tractors and 1800-lb cows were placed on it.

In summary, it can be stated that the steel structures in use have given excellent service and have proven to be satisfactory for dairy structures.

BACTERIOLOGY OF MILK FROM COWS IN LOOSE-TYPE BARNS

The conclusions reached as a result of bacteriological investigations reported by W. C. Frazier and his staff are as follows:

1 There is no significant difference in numbers or kinds of bacteria in milk as it leaves the udders of cows in stanchion-barn housing as compared with milk from cows with loose housing.

2 There is no indication that abnormality of milk from apparently normal quarters is greater in milk from one type of housing than from the other.

3 Milk of equally satisfactory bacteriological quality can be produced from cows housed in either a stanchion barn or in a pen barn.

INFLUENCE OF LOOSE HOUSING MANAGEMENT ON FLY POPULATIONS

The prevention and control of economically important species of flies appeared to be an important aspect of loose-housing management. Loose-housing management would occasion no greater fly problem than conventional dairy barns, if accumulated manure packs were removed early in spring, and the manure from the loose-housing barns was systematically removed during the summer. However, manure which has accumulated during the winter may, for a variety of reasons, remain in the barn during spring and early summer. This may result in a serious fly-breeding problem.

During the four summers, 1948 to 1951 inclusive, studies were made of manure packs retained during the spring and summer months. The conditions were varied to include isolation and drying of the pack compared with continuous or frequent occupation of the bedded area by cattle.

Conclusions made by cooperating entomologist, R. J. Dicke, are as follows:

1 In fly season, extensive breeding of economically important species of flies may occur in a manure pack frequently occupied by cattle during the period of retention.

2 Surface drying of a retained manure pack which is undisturbed by cattle will prevent fly breeding and will not present a sanitation hazard occasioned by fly breeding or attraction. Flytight concrete sidewalls may be essential for obtaining fly control in this way.

3 Poorly managed young stock pens indicated an appreciably greater fly-breeding hazard than a retained manure pack occasionally occupied by cows during milking periods.

SUMMARY

1 The housing facilities available at the Wisconsin Dairy Barn Research Project were satisfactory, under proper management, for high-producing experimental herds. The steel, one-story, insulated, stanchion barn provided an efficient housing unit throughout the years of study. The steel, one-story, insulated loose-housing barn, operated as a warm barn, was not a satisfactory barn for housing dairy cattle. This same insulated structure, operated with adequate ventilation from open doors and windows provided a satisfactory cold, loose-housing barn. The steel, uninsulated, cold loose-housing barn, operated with open doors and windows throughout the housing season, was an adequate and efficient housing unit throughout the years of study.

2 The experimental herds produced equally well under both systems of housing and management (warm housing in stanchion barns or cold loose housing). Milk of high quality was consistently produced under both systems of housing.

3 There was little difference between the general health of animals housed under the two conditions studied. However, the injuries observed in the stanchion housing (stepped-on teats, swollen hocks, stiffness and lameness) were almost completely absent in the loose-housing barns.

4 The experimental herds housed in the cold, loose-housing barns consumed 3 to 6 per cent more roughage than the experimental herds housed in the stanchion barn. The greater nutrient intake of the loose-housing herds may account for the observed higher gain in weight of the animals during the housing period.

5 The loose housing barns have consistently required more bedding than the stanchion barn. The amount of bedding used has varied from almost three times as much in the loose-housing barns in 1943-44 to about ten per cent more during 1950-51. During the last six years of study, the amount of bedding used in the cold, loose housing barn was almost 62 per cent more than was used in the stanchion barn.

6 The labor required in caring for the herds in the loose-housing barns was less than the labor required caring for the herds in the stanchion barn. This labor saving was as much as 35 per cent with an elevated stall milking parlor and pipe-line milking machine.

7 The barn temperature in the cold, loose-housing barn usually dropped to zero or below during each winter. A temperature of −23 F was recorded in this barn during 1950-51. No relationship between temperature and milk production was found in either system of housing. Some condensation occurred in both systems of housing, but did not appear to be too objectionable.

8 Loose housing in a closed, warm barn was found to be unsatisfactory.

9 Improved arrangement and design of loose-housing systems have been developed at the project. In general, they include the following areas:

(a) A *bedded area* providing at least 60 or 70 sq ft per cow (for Holsteins), cold, open and separate from all feeding or milking operations.

(b) A *feeding area* of 40 sq ft per cow providing room for the entire herd where batch feeding is used. This area should be paved and cleaned daily when located indoors. When located outdoors, it should be paved and cleaned as needed so as to control the cleanliness of the cows.

(c) A *sanitary milking parlor* with elevated stalls for ease and efficiency in milking the herd. Equipment for efficient milk production may include the pipe-line milker and bulk-milk facilities.

(d) *Feed and bedding storage areas* may be an integral part of the feeding and bedding areas, or located elsewhere if a convenient means of transportation is provided.

(e) An *outdoor lot* for exercise should be open to the sun and be partly paved for confinement during muddy weather. Protection from winter winds is also desirable.

(f) *Adequate young-stock housing facilities* conveniently arranged and protected from drafts.

Design standards for loose housing and recommended operational practices have been established, and published. In the preparation of these standards, the findings and experiences of this project have been used.

10 Manure packs in the bedded area of loose-housing barns should be removed in the spring when the herd is placed on pasture and well in advance of the fly season.

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Heating the Milkhouse with a Milk Cooler

By William G. Buchinger
MEMBER ASAE

HEATING the milkhouse with the milk cooler is probably the simplest, most economical and safest method known. Unfortunately, however, it is the least accepted.

There are two main reasons for the lack of popularity of this method. First is the farmer himself; he can readily see how heat can be taken out of warm milk, but he can't believe that heat can be taken out of cold well water. The second is that it would appear to require a complicated and expensive installation job. Actually it requires very little material or mechanical know-how to make the conversion. In fact, one way that the conversion could be made is by means of a piece of hose connected to the water faucet so that, when the milk cooling has been completed, the water could be turned on manually to flow into the cooler storage tank. However, this method would not be automatic and it would not be practical.

The conversion is simple because every milk cooler is in reality a heat pump, and when it is in operation it heats the milkhouse to a certain degree, both in winter and in summer. That is why the windows of the milkhouse are left open in the summertime — to increase ventilation and get rid of some of the excess heat that the milk cooler is releasing.

The heat that is given off is absorbed from the milk by the refrigerant in the evaporator coils or plates in the cooler tank. As the heat from the milk is absorbed, the refrigerant is in a liquid state. This raises the temperature of the refrigerant and causes the refrigerant to turn into vapor. The vapor is then condensed back into a liquid by the compressor unit and there the heat is released and distributed through the milkhouse by the small fan behind the condenser radiator.

Every ten-gallon can of milk will release into the milkhouse approximately 4400 Btu of heat by this method while the milk is being cooled from 95 to 40 deg, a difference of 55 deg. That is why some well-insulated milkhouses, where six or more cans of milk are cooled daily, are kept above freezing temperature without the aid of any additional heat source.

Regardless of how it is heated, it pays to have the milkhouse well insulated. The heat requirements can be reduced by two-thirds if 4 in or more of good insulation is provided in the ceiling, if the building is vapor-proof throughout, and if storm windows are installed. The ventilators should be set so that the opening is just large enough to let the moisture escape. Many milkhouses, however, cannot be kept above freezing temperature during the coldest part of the year without auxiliary heat. Therefore, if the milk-cooler is operated as a heater it will be possible to keep the temperature above freezing at all times.

The simplest way to convert the milk cooler into a heat pump is to install in the water-supply line a line-voltage magnetic solenoid valve, which sells for about $10 to $12. A ⅜-in solenoid valve is sufficient since it will discharge about 1¼ gpm of water at 40 lb pressure. This solenoid valve is controlled by an ordinary line-voltage room-heating thermostat, which sells for about $15 to $17. This thermostat should ordinarily be set for between 40 and 45 deg, which is warm enough for practically all milkhouses. If additional heat for personal comfort is desired while washing utensils, two or three type R-40 infrared heat lamps may be installed above the wash trays for this purpose.

Here is how it works. The water surrounding the ice bank in the cooler is at about 35 F. The new well water being introduced into the tank is usually between 45 and 50 F. Therefore, it can be reduced in temperature approximately 10 deg. With a 6-can cooler, a 10-deg drop in water temperature will release about 4500 Btu of heat per hour, which is more than the conventional resistance-type 1200-w heater will produce. A ⅓-hp or a ½-hp cooler compressor will handle such an output without appreciably affecting the temperature of the milk. In addition to these 4500 Btu, we can add 1700 Btu, which is the value of the energy used by a ½-hp electric motor, thus giving a total of 6200 Btu. That amount of heat is equivalent to an 1800-w resistance-type heater, which is adequate for heating almost any well-insulated milkhouse.

The amount of water needed to heat a 1,000-cu-ft milkhouse will be from 60 to 90 gph. However, this amount of water will not be needed many hours per day; and from one of the tests we have conducted, only 20,000 gal of water were used during the entire season. Of course, a good drain is necessary to take this water off rapidly during extremely cold periods, since this drain water is near freezing temperature. For this drain a simple pipe line can be connected to the cooler tank drain to allow the water overflow to discharge at a safe distance outside the milkhouse. This pipe should have plenty of fall and be at least 1 in in diameter. An underground tile drain to a lower level terrain or stream is also very satisfactory and is required in some states. The drain should not be connected to a cesspool or septic tank, since it would probably overload them.

In Michigan we have had good results with ⅓, ½, and ¾-hp milk cooler units. However, I believe that a minimum of ⅓-hp unit will be required to prevent freezing in milkhouses during days of lowest temperature.

The milk cooler motor and compressor, when used for this purpose, will not wear out any sooner than they would if used for milk cooling only. In fact, many refrigeration engineers believe that the operation of the compressor with more frequent recycling in winter in a warmer milkhouse, will reduce wear rather than increase it. None of the milk cooler manufacturers that I have consulted object to the milk cooler being used for this purpose, because the machine will not run any more during the winter months when it is used for milk cooling and heating the milkhouse, than it runs during the summer months when used for milk cooling only. So it is no harder on the machine when used for this purpose in the colder climates than it would be if it were used for milk cooling only in one of the southern states such as Florida, Texas, or Louisiana.

Normally, 3415 Btu per kilowatt-hour can be obtained from the conventional-resistance-type electric heater. However, with the heat pump or mechanical refrigeration unit, kilowatt-hours are not being exchanged directly for Btu, and it is possible to get up to three times as many Btu per kilowatt-hour of electricity as is possible by the direct-heat method.

In conclusion, I would like to point out that the advantages of using the milk cooler as a heat pump are as follows: (1) Conversion equipment is easy to install, (2) initial cost is low, (3) operating cost is low, and (4) equipment is safe — no flames, fumes, or hot heating elements. Used for heating the milkhouse, I believe the milk cooler is destined to become one of our most efficient pieces of electrical farm equipment.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1951, as a contribution of the Rural Electric Division.

The author: WM. G. BUCHINGER, farm service engineer, The Detroit Edison Company.

Correlation of Machinery and Conservation Practices

(Continued from page 624)

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INSTRUMENT NEWS

KARL NORRIS, Editor

Contributions about interesting agricultural applications of instruments and controls, and related problems, are invited, and should be sent direct to K. H. Norris, Agricultural Research Center, Beltsville, Maryland

A Constant-Feed All-Temperature Wet Bulb

By S. M. Henderson
MEMBER ASAE

THE wet bulb described in this paper was designed to provide a continuous unattended reliable record of wet-bulb temperatures through the temperature range of 32 F to approximately 190 F. It was further intended to be used in controlling relative humidity in a laboratory dehydrator.

Construction Details. The sensing unit (Fig. 1) is made of a piece of 16-mm glass tubing 2¼ in long. The glass tube which contains the thermocouple and supports the "sock" is 5 mm in diameter and fits the standard wet-bulb sock or wicking material. The exposed horizontal wick length *W* is approximately 1¾ in. The tube is bent to an approximate right angle and the distance *H* is minimized. The 30-gage copper-constantan thermocouple is located within the tube and about ⅛ in from the end. A unit designed for normal atmospheric temperatures has a wick tube fire-sealed at the end and filled with paraffine. A tube for high temperatures was not end sealed and was filled with electrical insulating varnish which was oven-baked.

The water level is maintained by a Mariotte bottle (Fig. 2). The bottom of the tube open to the atmosphere is at atmospheric pressure, as is the surface of the water in the unit *L*, Fig. 1. Consequently, if these points are aligned, the unit water level will remain constant as long as there is water in the bottle. Provision can be made for filling the bottle without disrupting operation. Distilled water should be used.

Pertinent Features. Reliable operation can be expected because of the following features:

1 The required capillary rise, less than *H*, is small thus assuring adequate vertical water movement even at high temperatures.

2 The wick extension *W* is long enough so that the thermal gradient between the sensing end and water level and the sensible heat of the water supplied for evaporation have no significant effect on the temperature at the sensing end. The thermal fill in the glass tube is further assurance of proper performance since it provides a thermal bridge between the thermocouple and wick and replaces air which would conduct heat by convection. The thermal fill should have a high conductivity, must be chemically inert, and must not expand or shrink with time or temperature.

3 Movement of water down the wick (length *W*) is by gravity. The unit can be tipped as shown by the angle θ thus placing the wick tip above, at, or below the water level *L*. This adjustment permits force feeding of the wick thus assuring an adequate water supply for any operating condition including that at high temperature. The angle can be adjusted so water can be observed hanging on the tip of the bulb but not dropping thus indicating complete bulb wetting.

4 The entire exposed wick, *W*, performs as a wet bulb. This further assures proper performance at the bulb tip.

5 The Mariotte bottle assures a constant unit water level *L*. Operation can be unattended.

Performance. Proper operating conditions for a wet bulb must be observed (2, 3).* The air rate past the bulb should be 500 to 1000 fpm. If significant radiant sources or sinks are present, the air rate should be close to the higher value. The radiation factor can be further minimized by decreasing the diameter of the bulb and may be eliminated by shielding.

Studies by Awbery and Griffiths (1) show that wet-bulb psychrometry is reliable for temperatures up to 212 F. Consequently, high-temperature psychrometric charts such as the one on page 766 of the Chemical Engineers' Handbook (4) may be used for air-vapor mixture determinations via wet and dry-bulb temperatures.

Units of this type have been used in field studies of grain drying. Continuous records of inlet and exhaust wet-bulb temperatures were recorded by a Brown multimillivolt recorder. Relative air rates and radiation intensity were variable. Recorded temperatures never varied more than a half degree from conventional psychrometric observations.

A unit installed in a laboratory dehydrator was checked at 170 F, dry-bulb and 87 F wet bulb, 3½ per cent relative humidity, at an air rate of 625 fpm, this being the most rigorous condition under which the dehydrator could be operated. The unit attached to a potentiometer gave the same temperature as a laboratory wet-bulb thermometer. The unit was tipped to feed water off the end of the bulb. A 2½ drop-per-minute rate caused no temperature error. Five drops per minute caused a temperature rise of approximately 1 F; 12 drops, 1½ F.

The dehydrator unit was combined with a millivolt controller and a modulating solenoid valve in a steam line. This combination has performed admirably as a relative humidity or wet-bulb temperature control.

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*Numbers in parentheses refer to the appended references.

Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Davis, Calif., January, 1952.

The author: S. M. HENDERSON, agricultural engineering division, University of California.

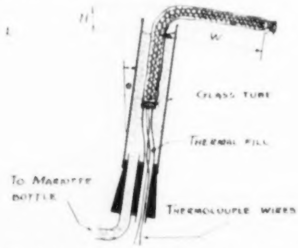


Fig. 1 (*Left*) The wet-bulb sensing unit with water reservoir • Fig. 2 (*Right*) The Mariotte bottle used for maintaining the water level in the sensing unit

What Is Meant by "Standards"?

THE term "standard" means accurately defined processes, sizes, qualities, and tests of materials and equipment that have been generally agreed upon by makers, users, and the public, as proper and desirable for general use. A standard may be brief, only a sentence or a paragraph, while again it may be a very long, and in some cases a highly technical document.

Standards represent a vital economic need, and have a beneficial effect on the national economy.

The advantages of standardization have been recognized by industrialists for many years, and the economic problems that develop during periods of war have been found to be a great incentive toward development of standards. — W. R. McCaffrey in *Mechanical Engineering* for August, 1952.

NEWS SECTION

ASAE Winter Meeting Program

A NEW environment for the Winter Meeting of the American Society of Agricultural Engineers this year will help emphasize the purpose of the meeting — thinking ahead to a new year and a new era, the beginning of a second century of engineering.

The new environment will be the Edgewater Beach Hotel, on Chicago's north side. This year's meeting there, December 15 to 17, is a step in a direction strongly urged by many members in recent years, toward scheduling the meeting earlier in the month, longer before the Christmas rush. Only a few days were gained this year, but arrangements have already been made to hold the meeting there a week earlier in 1953. The earlier date has not been open at the previous headquarters hotel. It is expected that wider corridors and more ample meeting rooms will contribute further to the comfort and effectiveness of the occasion.

In basic plan there will be little change. Each of the four ASAE technical divisions has arranged a program featuring primarily recent and current technical developments related to current problems and progress of wide interest to agricultural engineers. There will be two joint programs of two divisions, some formal and informal committee meetings, and the usual friendly unscheduled but important man-to-man interchange of ideas and information.

Two Joint Programs

One of the newer factors entering into the calculations of agricultural engineers has prompted a joint symposium on the subject "Soil Conditioners — Possibilities and Problems." The Power and Machinery and Soil and Water Divisions are joint sponsors. This session is scheduled for Tuesday forenoon, December 16, with Ivan D. Wood, president of ASAE, serving as chairman. It will open with a presentation on "Soil Conditioners as Related to Soil Conservation," by C. S. Slater, Soil Conservation Service, USDA. Discussion of this phase will be followed by a paper on "Results of Tests of Soil Aggregating Chemicals," by W. P. Martin and G. S. Taylor, Ohio State University. They will report on investigations from an agronomic viewpoint. W. C. Hulburt will follow with a discussion of the agricultural engineering interest in "Application Problems in the Use of Soil Conditioners."

Getting together on some of their closely related interests, the Farm Structures and Rural Electric Divisions will also hold a joint session on Tuesday forenoon, December 16. D. B. Poor, chairman of the Farm Structures Division, will preside during the first half of the session.

One item to be covered is a report by A. D. Edgar, U.S. Department of Agriculture, on "New Developments in Potato Storage."

A panel on "Latest Information on Grain Drying and Air Requirements for Grain Storage" is to feature three related contributions. Geo. H. Foster of Purdue University and the U.S. Department of Agriculture will cover "Minimum Airflow Requirements with Unheated Air." L. W. Hurlbut, University of Nebraska, is to report on "Practical Experience with Minimum Air Flows with Unheated Air." W. V. Hukill of Iowa State College and the U.S.D.A. will call attention to new data on "Grain Cooling by Air."

Following an intermission, A. H. Hemker, chairman of the Rural Electric Division, will take over as presiding chairman. He will introduce first a study by K. H. Hinchcliff, M. W. Forth, and L. S. Foote, University of Illinois, on the "Relationship of Farm Building Layout and Electrical Farm Equipment."

Rounding out the session, several industrial representatives are to report briefly on new equipment. These will include the subject of a "Chopped Hay Self Feeder and Drier," by Ray Arndt, Habco Mfg. Co.; "Semi-Pressure Propeller Fan," by Nolan Mitchell, Aerovent Fan and Equipment Co.; "Small Buildings for Drying and Storing Grain," by D. B. Poor, Stran-Steel Div., Great Lakes Steel Corp.; "Wagon Batch Drier," by B. C. Mathews, American Crop Drying Equipment Co.; and "Equipment for Measuring Humidity," by W. H. Kliever, Minneapolis-Honeywell Regulator Co.

A further interest common to all divisions will be a contribution on "Preparation and Presentation of Lantern Slides," by B. A. Jones, Ethyl Corp. It is on the program of each of the two joint sessions, for the convenience of the audience.

Power and Machinery Program

R. I. Worrell, chairman of the Power and Machinery Division, will call that group to order Monday forenoon, December 15, for an opening session featuring a symposium on "Methods and Correlation of Field Testing with the Design of Farm Machinery." Scheduled contributors include Thomas Carroll, Massey-Harris Co., Ltd.; Guy E. Woodward, New Holland Machine Div., The Sperry Corp.; and Sherman C. Heth, J. I. Case Co.

Harvesting machine design considerations will be further developed in the afternoon session with contributions on "Power Requirements of Various Drives in a Combine," by D. E. Burrough, Purdue University; "Design Requirements of a Plunger-Type Baler," by D. E. Burrough and J. A. Graham, Purdue University; and a "New Approach to Combining Corn," by Geo. E. Pickard and D. F. Hopkins, University of Illinois.

The Tuesday forenoon program, December 16, will be joint with the Soil and Water Division, as reported above. It will be followed by an open afternoon permitting the power and machinery engineers to arrange contacts in line with their individual interests.

A symposium on "Fasteners to Meet Farm Equipment Requirements" is on the schedule for Wednesday forenoon, December 17. It will open with a paper on "Strength and Trends of Bolted Assemblies," by John S. Davey, Russell, Burdsall and Ward Bolt and Nut Co. He will be followed by Fred C. Ewart, Deere and Co., speaking on "Availability and Adaptability of Fasteners, New and Old." Thus introduced, the matter of fasteners will be discussed by several engineering representatives of the farm equipment industry.

"Fatigue Failures in Farm Machinery" will be considered in a symposium scheduled for the closing session, Wednesday afternoon. It is being arranged by Charles Lipson, industrial consultant, Detroit, Mich., who will be one of the speakers. Additional speakers are to be announced in the near future.

Soil and Water Program

In addition to the joint session on soil conditioners, the Soil and Water Division offers one session each on drainage, irrigation, and flood control.

The drainage session will open Monday forenoon, December 15, at 9:30, with A. J. Wojta, vice-chairman of the Division, presiding. "Drainage as an Agricultural Practice" will be the subject of W. S. Lynes, consulting engineer and speaker, Iowa House of Representatives. Mr. Lynes is widely known as one of the leading authors of drainage laws in Iowa.

"Techniques for Drainage Investigations in Irrigated Areas" will be dealt with by R. C. Reeve, U.S. Salinity Laboratory, USDA, at Riverside, Calif. His subject represents a major western interest in drainage technology.

"Machinery Aspects of Drainage" is a topic under which I. L. Saveson, Soil Conservation Service, U.S. Department of Agriculture, will report on investigations and practice in the South. Mechanical equipment and methods for installing and improving drainage at minimum cost and influences of drainage on farm field equipment operation are matters of wide interest.

"Drainage Contracting" as a midwestern practice affecting drainage results and economy, is to be reviewed by K. W. Hotchkiss, drainage contractor, Albert Lea, Minn.

Attention will be concentrated on problems and practices of the sprinkler method in the irrigation session Monday afternoon, December 15. "Supplemental Irrigation for Field Crops and Pastures" will be presented from a southern viewpoint by W. J. Liddell, Southern Irrigation Co.

Claude H. Pair, Soil Conservation Service, USDA, is to describe "A Quick Field Method of Evaluating Sprinkler Systems and Their Operation."

"Conservation of Soil and Water as Related to Sprinkler Irrigation" will be the subject of A. S. Gray, National Rain Bird Sales and Engineering Corp.

Wayne D. Criddle, chairman of the ASAE Committee on Irrigation, is to preside at the session. (News continued on page 648)

ASAE Meetings Calendar

October 25—MICHIGAN SECTION, Agricultural Engineering Bldg., Michigan State College, East Lansing.

October 28—MINNESOTA SECTION, Agricultural Cafeteria, University of Minnesota, University Farm, St. Paul.

October 30 - November 1 — PACIFIC NORTHWEST SECTION, Oregon State College, Corvallis.

November 14—IOWA-ILLINOIS SECTION, somewhere in the Quad-Cities.

December 15-17—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

June 15 to 17 — 46TH ANNUAL MEETING, Hotel William Penn, Pittsburgh, Pa.

NOTE: **Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Michigan**

NEWS SECTION (Continued from page 646)

On the high-level side of water problems, the closing session on "Flood Control" Tuesday afternoon, December 16, will develop the outlook of engineers in the U.S. Soil Conservation Service. It will open with a presentation on "Flood Prevention" by Carl Brown, assistant chief of operations, Soil Conservation Service. "Hydrology and Sedimentation," as considerations in flood control, will be the subject of Louis Glymph. Applications of flood control engineering to a specific area will be dealt with by Clifford Sanders speaking on "The Flood Prevention Plan for the Salt-Wahoo Watershed." G. E. Ryerson, chairman of the Soil and Water Division, will preside.

RURAL ELECTRIC PROGRAM

A broadening base of technical interest in rural electrification is reflected in the range of subjects marked for attention. A. H. Hemker, chairman of the Rural Electric Division, will call the meeting to order Monday forenoon, December 15.

Scheduled for the opening session are contributions on "Use of Electric Dehumidifiers and Lights in Grading and Sorting Burley Tobacco," by I. I. Koontz, Appalachian Electric Power Co.; "A New Kind of Barn Cleaner," by R. G. Ferris, Starline, Inc.; "Electric House Heating—Its Effect on Rural Distribution," by S. J. Marek, Rural Electrification Administration, USDA, and "Light, Its Effect on Plant Growth," by Harry Borthwick, USDA.

"Electronics in Agriculture" will be the theme for Monday afternoon's session. E. T. Swink, vice-chairman of the Division, will preside. "Electronic Color Sorting of Fruits and Vegetables," by John B. Powers, University of California, will cover a development in progress at that institution for some time.

Leo T. Soderholm, Nebraska Agricultural Experiment Station and the USDA, is to report results of research on "Effect of Dielectric Treatment on Wheat Weevil and Pink Boll Worm."

In another contribution from the University of California, John B. Dobie, F. C. Jacob, and L. C. Kleist will report on "Electronic Detection and Removal of Tramp Iron from Chopped Hay."

"A Progress Report on Black Light Moth Attraction," by John G. Taylor of the Purdue Agricultural Experiment Station and the USDA, is the concluding number.

An informal open forum on "Crop Drying With and Without Heat" has been scheduled by the Division for Monday evening, December 15. The presiding officer will be E. R. Mayner of the Crop Drying Manufacturing Assn. and Martin Steel Products Co.

Following Tuesday forenoon's joint session announced above, the afternoon will be devoted to heating, power, and wiring interests. The opener will be a panel discussion on "Infrared Brooding." J. P. Ditchman as leader will call for contributions from Wm. Stoll, Arco Light Corp.; R. L. Heston, National Assn. of Mutual Insurance Companies; Ross Mauney, Arkansas Power and Light Co.; and Fred Slater, Jackson County REMC, Brownstown, Ind.

A report of the ASAE Committee on Feed Handling is next to be presented by H. C. Rutt, Public Service Co. of Northern Illinois. The report is expected to cover some interesting developments in automatic feed handling installations in Illinois.

"New Developments in Electric Motors" are to be brought before the audience by S. I. Miles and M. J. Carroccio, General Electric Co.

The audience is to be brought up to date on "The Heat Pump in Agriculture" by C. P. Davis of Kansas State College and the USDA.

A motion picture on "Wiring for the Home," presented by D. W. Rice of the National Electric Products Corp., will conclude the session and the Division program.

FARM STRUCTURES PROGRAM

Timely themes characterize the three sessions scheduled by the Farm Structures Division in addition to the joint session in which it will participate as noted above.

"Animal Housing as Affected by New Trends in Animal Production and Management" will be the central interest in the opening session Monday forenoon, December 15. D. B. Poor, division chairman, will preside.

"Organization of Building Space for Beef Cattle" is booked as an opener. At this writing the selection of an authoritative speaker is still in progress.

"New Developments in Hog Housing with Special Consideration to Pig Hatcheries" will be reviewed by C. W. Mitchell, *Breeder's Gazette* and the Poland China Record Assn.

"Poultry Housing" will be dealt with under two subheadings. That for "Egg Production" is to be handled by Milton R. Dunk, *Poultry Tribune*. That for "Meat Production" will be covered by Alec Gordeuk, *Broiler Raising*.

"Structural Design" is the Monday afternoon session theme. Presiding for this period will be N. H. Curry, vice-chairman of the Division.

"Factors Affecting the Design and Fabrication of Curved Barn Roofs" will be presented by J. H. Pederson, Iowa State College.

M. L. Burgener, Portland Cement Assn., will contribute a paper on Prestressed Concrete Design.

"A Study of Wind Damage to Farm Buildings" will be reviewed from a structural design standpoint by J. F. Scofield, Cornell University.

"Analysis of 'The Diaphragm Action of Haymow Floors,'" by D. V. Doyle, Forest Products Laboratory, USDA, will conclude the design session.

Tuesday afternoon's session, with C. K. Otis, past-chairman of the Division, presiding, will feature "Materials and Material Protection."

"A Report on the Field Study of Farm Building Materials in the North Central Region," by A. C. Dale, H. J. Barre, and J. L. Schmidt, Purdue University, will introduce the consideration of materials.

"Tests on Aluminum" are to be reported by F. M. Reinhardt, National Bureau of Standards.

Francis Scofield, National Paint, Varnish and Lacquer Assn., is scheduled to present "What's New in Paint and Painting Methods."

"Absorption Rates of Penta by Various Species of Wood Types," a contribution by L. W. Neubauer, University of California, is the concluding item on the structures program.

GRASSLAND FARMING

A "grassland farming" program of interest to many agricultural engineers has been scheduled for Thursday, December 18, the day following the conclusion of the Power and Machinery program. It is sponsored by the Joint Committee on Grassland Farming, of which the ASAE is one of the cooperating organizations.

(EDITOR'S NOTE: **See page 662 of this issue for program on grassland farming.**)

Pacific Northwest Section Program

GRASSLAND farming, resources for freedom, LP gas equipment, irrigation and extension, phase convertors and student branch papers are major items featured in the general sessions program for the Pacific Northwest Section at Corvallis, Ore., October 30 to November 1. There will also be afternoon and evening concurrent programs in the four major technical branches of agricultural engineering, as well as a banquet, business meeting and election of officers, entertainment, and field trips.

To encourage early arrivals registration is scheduled to open at 6:30 p.m. Wednesday, Oct. 29, at the Memorial Union Building, Oregon State College, followed by entertainment at 8:00 p.m.

Registration will be resumed at 8:00 a.m., Thursday, Oct. 30. At 9:30 Jesse E. Harmond, chairman of the Section, will call it to order for a general session featuring first an address of welcome by A. L. Strand, president of Oregon State College. Ivan D. Wood follows on the program with a report on national activities of the ASAE.

"The Key to Grassland Farming—The Agricultural Engineer," is the title of an address to be presented at this session by E. W. Hamilton, Allis-Chalmers Mfg. Co.

G. W. Gleeson, dean, school of engineering, Oregon State College, will address the session on "Resources for Freedom."

First event of the afternoon will be the Section business meeting and election of officers. It will be followed by four concurrent technical programs.

S. J. Mech, Soil Conservation Service, USDA, will preside at the soil and water session, featuring contributions on "Soil-Water-Plant Relationships," by F. J. Veihmeyer, University of California; "An Economic Study of Sprinkler and Surface Irrigation on the Columbia Basin Project," by R. O. Rogers, Bureau of Reclamation, USDA, and "Problems in the Development of New Land on the Columbia Basin," by M. W. Hoisveen, Bureau of Reclamation.

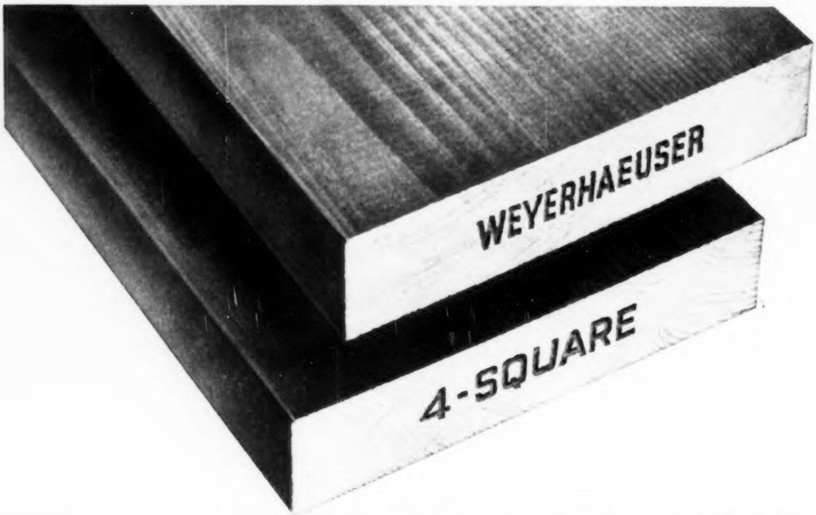
In the power and machinery group W. H. Johnson, State College of Washington, will be the chairman. He will introduce J. R. Turner, Shell Chemical Corp., for a contribution on "Liquid Fertilization," and Thomas Jackson, Oregon Agricultural Extension Service, who will talk on "Placement of Nitrogen Fertilizer for Dry Land Wheat Production."

Electric power for irrigation will be considered by the rural electric group. R. E. Gale, Idaho Power Co., is to report on "The Development of Electric Pumping for Irrigation in the Rupert, Idaho Area." This will be followed by a contribution on "Electric Motors and Their Application to Irrigation Pumping," by W. Forsyth, Multnomah Iron Works. P. R. Bakes, Washington Water Power Co., will serve as chairman.

Dairy housing will receive major emphasis in the farm structures session, following a treatment of "Residential Heating with the Perimeter Warm Air System," by Floyd B. McCloud, Rushlights, Inc. The following four scheduled contributions on dairy housing are "Introducing the Western Regional Dairy Structures Research Project," by J. B. Rodgers, Oregon State College; "Stanchion Barn Versus the Milking Barn, and Shed Space Requirements for Dairy Cattle," by W. R. Friberg, University of Idaho; "Influence of Dairy Structure Design on Milk Quality and Operating Efficiency," by W. L. Bonnicksen, Oregon State College, and "Requirements of Housing for Rearing Dairy Calves," by J. Roberts, Washington State College.

At 6:00 p.m. a complimentary dinner for students and Student Branch faculty advisers is being provided through the courtesy of R. M. Wade and Co. Robert M. Morgan of that organization will serve as host.

(News continued on page 652)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"PIANO PLAYER" this man is called. He operates a team of high speed saws, individually controlled from the "keyboard."

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The answer to that question depends in part on the skill, the training, the experience of many different men doing many different jobs. Each log must be appraised as an individual problem by men with the know-how needed to get the most out of it, with the least waste and in the least amount of time.

In a Weyerhaeuser mill, for example, a single man, the head sawyer, makes thousands of decisions in a single day . . . determining where and how to cut to secure the greatest yield of good lumber from every log. This is just one example of why Weyerhaeuser places such emphasis on getting the best men in the industry for each of the many dozens of highly technical operations necessary to the job of producing high quality Weyerhaeuser 4-Square Lumber.

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NEWS SECTION (Continued from page [illegible])

Concurrent technical programs will be resumed at 8:00 p.m. At these sessions each group is to elect its own chairman and vice-chairman for the succeeding year.

A research committee report will be presented by T. L. Coulthard, University of British Columbia, in the soil and water session.

Research reports by representatives of research agencies will be presented for consideration by the power and machinery men.

The rural electric group is to hear two papers: "This Canada you Hear About," by R. H. Grant, British Columbia Electric Co., and "Ground Water Supplies in the Pacific Northwest," by Hugh Naismith, Department of Mines, Victoria, B. C.

"Bulk Handling and Farm Products," by W. I. Griebeler, Douglas Fir Plywood Assn., and "Mid-Century Architecture," by H. R. Sinnard, Oregon State College, are to be considered by the farm structures group.

H. B. Howell, vice-chairman, is to preside at the Friday morning general session. "Observations on LP Gas Equipment," by a representative of J. I. Case Co., will be the first item on the program.

"Farm In A Day" is the title of a moving picture to be shown, with supplementary comments by Joseph Weston, Douglas Fir Plywood Assn.

Relationships between "Irrigation and Extension" are to be outlined by J. D. Wood, Soil Conservation Service, and president of ASAE.

Following an intermission, T. L. Coulthard, vice-chairman, will take over the presiding duties to introduce G. O. Toms of Spokane, Wash., who will talk on a "Phase Convertor for Running Three Phase Motors from Single Phase Power Service."

Student branch activities will be featured during the balance of the morning, with Verl King, chairman for student activities, presiding. Student award papers from each of the four college agricultural engineering departments in the Section area are to be presented, followed by brief reports of student branch activities.

Concurrent technical group sessions provide a full schedule for the afternoon.

John Wolfe, vice-chairman for the soil and water group, will preside over a program offering a "Farmer's Viewpoint on Irrigation," by Ed Freudenthal, Hillsboro, Ore.; "Industry's Viewpoint on Irrigation," by R. W. Morgan, R. M. Wade and Co.; "Reclamation of Alkali Land," by Dawson Moodie, Washington State College; "Water Use Studies," by Albert Marsh, Oregon State College; and "Irrigation in Nebraska," a movie to be shown by M. N. Shearer, Oregon Agricultural Extension Service.

The power and machinery group will use this period for a round table discussion of "LP Gas Equipment." H. I. Gray, vice-chairman will preside.

Four diverse subjects are on the rural electric schedule, namely, "Safety in Handling Irrigation Pipe," by W. H. Knight, University of Idaho; "Electrical Display Featuring Effects of Lighting and Coloring," by a representative of the General Electric Co.; "Electric Pumps and Controls," by Ben W. Faber, Hillsboro, Ore.; and "Farm Refrigeration Research," by M. C. Ahrens, U.S. Department of Agriculture. T. K. Dimmitt, vice-chairman, will be in charge of the session.

"Reducing Annual Cost in Farm Structures" will be the theme before the structures men, with P. L. Moen, vice-chairman, introducing the speakers. Presentations under this heading will include "Income Producing Improvements versus Farmstead Depreciation," by N. R. White, Stran-Steel Products Co.; "Plywood Construction," by W. I. Griebeler, Douglas Fir Plywood Assn.; "Packaged Unit Building," by Charles Walte, Jr., Reynolds Farm Institute; "Preservation of Farm Structures," by W. R. Bond, American Wood Preservers Assn.; "Timber Rib Construction," by a representative of Timber Structures, Inc.; and "Use of Lumber in Farm Building," by Mr. Moen, Weyerhaeuser Sales Co.

A particularly notable program has been arranged for the banquet beginning at 7:00 Friday evening. Toastmaster will be Wade Newbegin, R. M. Wade and Co. The Hon. Douglas McKay, governor of Oregon, is expected to be present and to extend greetings. Marshall H. Dana, assistant to the president, U.S. National Bank of Portland, is to be the speaker of the evening.

Details have not yet been announced concerning Saturday morning field trips to begin at 8:30. In the afternoon interest will center on football, with the game between Oregon State College and the University of Washington representing the major contest in the area.

Minnesota Section Meets October 28

ORIGINALLY scheduled a week earlier, the fall meeting of the Minnesota Section of the American Society of Agricultural Engineers will now be held Tuesday, October 28, at 6:15 p.m., in the party dining room of the Agricultural Cafeteria on the University of Minnesota farm campus at St. Paul. The program will feature J. H. Miller, USDA, on research in chemical weed control, and W. G. Shelley, O. W. Kromer Co., on equipment for chemical weed control.

Any agricultural engineers outside of the section area, especially any who may happen to be in the Twin City vicinity at the time, are cordially invited to attend the meeting.

The 1952 NFEC Program

RURAL electrification's annual open house on extension and promotional work will be held October 19-21, at the Statler Hotel in Detroit, at the annual National Farm Electrification Conference.

A new feature of the meeting this year is the Sunday opening, October 19, with a steering committee session scheduled for 3:00 p.m. and registration, a social meeting, and informal discussion scheduled for 7:30 Sunday evening. "Imagineering in Rural Electrification" will be the theme of the evening, with G. E. Henderson serving as discussion chairman.

"Wired Men — Not Hired Men" is the theme behind the program for Monday morning, October 20. A. W. Farrall, Michigan State College, is the general chairman for this portion of the program, which will open with a welcome from Walker L. Cisler, president, Detroit Edison Co. John Strohm, associate editor, *Country Gentleman*, is to keynote the session with a talk on "Rural Electrification in Our Expanding Economy."

The women's viewpoint will be appropriately represented in the section on rural electrification in the home. Miss Karen Fladoes, Kelvinator Division, Nash-Kelvinator Corp., will preside. Elaine Weaver, Ohio State University, will discuss "Getting the Most from Electric Power in the Home." Olivia Meyer, Michigan State College, is to speak on "Labor Saving in the Home and Laundry."

"Lighting in the Home" is the subject of L. H. Hruby, General Electric Co. "Comfort Control in the Home" will be the subject of Arthur DePuy, Minneapolis-Honeywell Corp.

"Equipment Manufacturers' and Dealers' Problems" will be discussed by a panel including Mrs. Mariquita Dygert, Detroit Edison Co., presiding; J. M. Wicht, American Home Laundry Manufacturers Assn.; and J. A. Kemper, Vacuum Cleaner Manufacturers Assn.

Dawson G. Womeldorff, Public Service Co. of Northern Illinois, presiding over the farmstead section, is to introduce subjects and speakers as follows:

"Farm Wiring Problems and Their Solutions," a panel discussion by J. F. Grolean, National Electrical Contractors Assn., and H. J. Kapphahn, Michigan State College.

"Youth Activities in Rural Electrification," by R. T. Jones, Pennsylvania Power and Light Co.

"Report on the Rural Electrification Association Electric Farming Program," by S. Riggs Shepperd, assistant administrator, REA, U.S. Department of Agriculture.

"Report on the Edison Electric Institute Farm Program," by Edward Smith, Dayton Power and Light Co.

An afternoon session presided over by A. H. Hemker, General Electric Co., will open with reports on the morning section meetings by Miss Fladoes and Mr. Womeldorff.

"A Farmer's View of Rural Electrification Problems and Possibilities" is to be given by Stanley M. Powell.

What is available in "New Electrical Equipment for the Farm" will be summarized by W. D. Hemker, Westinghouse Electric Corp.

"Rural Electrification Research" will be presented by T. E. Hienton, U.S. Department of Agriculture.

A complimentary recreation hour and a conference banquet are scheduled for the evening.

"Putting Across the Story of Rural Electrification" is the theme for the Tuesday morning session. Hobart Beresford, Iowa State College, will preside for the opening period, featuring a presentation on "Modern Methods of Communication," by Paul Bagwell, Michigan State College.

In section meetings to follow, Milon Grinnell, *Michigan Farmer*, will preside over a session on "Putting Across the Story by Farm Press, Radio, and Television." Scheduled contributions to this session include "Opportunities for Service," by Charles E. Ball, *The Farm Journal*; "Source Materials," by Herman J. Gallagher, Consumers Power Co.; "Making the Farm Paper More Effective," by Ralph Foster, *Capper's Farmer*; "Telling the Story by Means of Industrial Publications," by W. J. Ridout, *Electricity on the Farm Magazine*; and "Getting the Story to the Farmer by Radio," by Marshall Wells, WJR, Detroit.

At the same time another section, with G. W. McCuen, Ohio State University, presiding, will give attention to "College and Industrial Extension in Rural Electrification." Special phases scheduled for development are "Opportunities for Service," by Ralph Parks, University of California; "Source Material and Extension Methods," by H. S. Pringle, Extension Service, U.S. Department of Agriculture; "Industry Methods of Extension," by R. E. Johnson, Toledo Edison Co.; and "Keeping the Farmer Tuned to the College Radio," by R. J. Coleman, Michigan State College.

Following a luncheon, the afternoon session will open with A. W. Farrall presiding. Summaries of the two section meetings in the morning will be followed by presentations on "How Can the Electrical Industry Best Serve the Housewife," by Mrs. Maurine Harris, *Successful Farming*; "A Program for Promotion of Farm Water Systems," by Walter Deming, Deming Pump Co.; and "The Present and Future Role of Television in Agricultural Education," by Armand Hunter, Michigan State College.

The conference will close with a report of the steering committee, and a "Summary of the Conference with Suggestions for Action," by H. E. Slusher, Missouri Farm Bureau Federation.

(News continued on page 654)

NEWS SECTION *(Continued from page 652)*

Ridout New Chairman of North Atlantic Section

W. J. RIDOUT, JR., editor, *Electricity-on-the-Farm* magazine, New York City, was elected the new chairman of the North Atlantic Section of the American Society of Agricultural Engineers at the regular yearly meeting of the Section, held this year on the campus of the University of Maine at Orono, August 25 to 27. He succeeds A. D. Longhouse, head, agricultural engineering department, West Virginia University. The new vice-chairman elected at the meeting is C. G. E. Downing, head, agricultural engineering department, Ontario Agricultural College, Guelph. Morris H. Lloyd, agricultural engineer, Niagara Mohawk Power Corp., Buffalo, was re-elected as secretary of the Section.

In spite of the fact that the Section meeting was held at a considerable distance from the center of Section membership, it was one of the most largely attended meetings in the history of the Section. The registered attendance was 166, with a total attendance of 307, including women and children. Needless to say, many of those attending the meeting combined it with a vacation which, together with the excellence of the program, were the two most important factors favoring such a large attendance.

While there was some question about the Section holding its yearly meeting during 1953, owing to the fact that the parent society's annual meeting next year will be held in the Section area, the Section voted overwhelmingly at its business meeting to hold its 1953 meeting as usual.

PERSONALS OF ASAE MEMBERS

William H. Aldred recently joined the staff of the agricultural engineering department at New Mexico A. & M. College. He was previously an instrument inspector in the DuPont organization at Augusta, Ga.

Charles G. Burress, professor and head of agricultural engineering extension at the Pennsylvania State College, is on sabbatical leave for the second half of this year. He is serving as an agricultural engineering consultant with the sales development division, Aluminum Co. of America, New Kensington, Pa., and giving attention to some special problems involving the use of aluminum in agriculture.

Earle F. Cox was recently named chief engineer, tractor division, Harris Mfg., Stockton, Calif. His previous experience includes several years in farm equipment design with the Allis-Chalmers Mfg. Co., and several years as research professor of agricultural engineering at the University of Massachusetts. In his new work he will have charge of engineering on the Harris four-wheel-drive tractor and the Harris self-propelled hillside combine.

Cleve H. Milligan is on leave from his duties as head of the irrigation and drainage department, Utah State Agricultural College, and is carrying out an assignment in Iran where he has charge of the agricultural engineering program in the Point IV activities in that country. The main efforts in the program are in the farm machinery and irrigation fields.

(Continued on page 656)

This new agricultural engineering building at the North Dakota Agricultural College will completely house classrooms, laboratories, and offices for the agricultural engineering department at that institution. The two-story addition to a three-wing laboratory will take care of the 45 agricultural engineering students now enrolled at NDAC. The laboratory space includes divisions for farm power and machinery, farm structures, rural electrification, soil and water conservation, and other related subjects. The $115,000 addition was completed in July

PERSONALS OF ASAE MEMBERS

(Continued from page 654)

EDWARD A. KARATH, formerly employed as an agricultural engineer in the U.S. Soil Conservation Service, now holds the position of agricultural engineer of the Iowa Natural Resources Council, State House, Des Moines.

T. VINCENT OPPENHEIM, formerly market analyst, New Idea Farm Equipment Co., Division of Avco Mfg. Co., is now associated with the advertising agency, Botsford Constantine & Gardner, San Francisco, as research director.

ROBERT B. RHOADS recently returned to his alma mater, the University of Maine, to fill a position in farm power and machinery teaching and research. Since receiving his bachelor's and master's degrees in agricultural engineering there he has been associated with Harry Ferguson, Inc.

PAUL W. STONEBURNER, recently resigned as research associate in agricultural engineering, Virginia Agricultural Experiment Station, to become sales engineer for Atlantic Aluminum Company. He will headquarter at Waynesboro, Va., and will specialize in the sale of the Company's aluminum agricultural products for irrigation and farm buildings.

CLYDE WALKER is on leave from his position as agricultural engineer of the Portland General Electric Company to carry out an assignment in Jordan where he will be in charge of an agricultural engineering program in the Point IV activities in that country. His assignment is for a two-year period.

NECROLOGY

GEORGE R. BOYD, retired agricultural engineer of the U.S. Department of Agriculture, passed away at his home in Silver Spring, Md. September 16, at the age of 70.

A native of Red Oak, Iowa, and a graduate in civil engineering from Iowa State College, Mr. Boyd entered the Department of Agriculture in 1908 as an agent in irrigation investigations for the Office of Experiment Stations. He was head of the division of mechanical processing of farm products in the Bureau of Plant Industry, Soils, and Agricultural Engineering when he retired June 30, 1952.

During his 44 years of government service Mr. Boyd handled many responsible assignments. He was assistant chief of the former Bureau of Agricultural Engineering and was in charge of agricultural engineering research for a time after the Bureau was abolished. He was in charge of processing and distribution of surplus explosives for agricultural use following World War I. He was the Department liaison officer with the Works Progress Administration. For many years he was responsible for the design and construction of all USDA research buildings, including such large projects as the four regional research laboratories, the Plant Industry Station, and the Agricultural Research Center.

Mr. Boyd was a captain in the Engineering Reserve Corps with active service in France during World War I. A member of ASAE since 1922, Mr. Boyd was active for many years in what is now its Soil and Water Division. He was also a member of the American Society of Military Engineers and the American Society of Civil Engineers.

He is survived by three sons: George R. Boyd, Jr., Ashland, Va., Foster B. Boyd, Baltimore, Md., and Lieut. Ellsworth Boyd, USAF, stationed at Patrick Air Force Base, Fla., and a sister, Dr. Laura A. Boyd of Holland, Mich.

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ELMER WILLIAM HENRY, product designer, B. F. Avery Division, Minneapolis-Moline Co., Louisville, Ky., was killed in an automobile accident near Bedford, Ky., on August 16. Also fatally injured in the same tragedy was Mrs. Henry and a six-year-old son, Bruce.

Born at Marietta, Ohio, on April 5, 1910, Mr. Henry was granted a bachelor of science degree in agriculture by Ohio State University in 1933. Following graduation he was employed by the U.S. Soil Conservation Service as an engineer and agronomist, working in the state of Ohio on projects having to do with erosion control, reforestation and land use. Mr. Henry later served as junior forester, U.S. Forest Service, in Alabama, on timber estimating, land acquisition, and land surveys.

In 1936,he was appointed acting instructor in soil conservation and farm machinery in the department of agricultural engineering, A. & M. College of Texas. From 1936 to 1938, he was engaged in graduate work in farm power and machinery at the University of Minnesota. This training led him in 1939 to an affiliation with the Massey-Harris Co., Racine, Wis., with the principal duties of service work on field machinery and engineer in the harvester division, and later to the connection he held at the time of his tragic passing.

As a product designer, Mr. Henry had the respect of his associates and competitors in the field of farm power and machinery. One of his most outstanding accomplishments while in Louisville was the design of the Minneapolis-Moline mower, Model MO. On his own initiative he pioneered in the slit method of tillage and reported on his views in the May, 1952, issue of AGRICULTURAL ENGINEERING.

He is survived by one daughter, four-year old Jane, who escaped unhurt from the accident.

Another

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. . . has felt-lined steel flingers rotating in labyrinth to prevent entry of dirt and to retain proper amount of lubricant (see 4).

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. . . prevents bearing from spinning in its housing and prevents fretting corrosion between housing and bearing, yet permits sufficient shaft alignment without seal distortion (See 5 and 6).

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. . . rides on the ground inner surface of the outer race ring (See 7), eliminates ball wear, trapping grease and preventing its churning in the bearing.

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Applicants for Membership

The persons listed below have applied for admission to membership or for transfer of membership grade, in the American Society of Agricultural Engineers. Members of the Society who wish to commend or object to any of these applicants, should write the Secretary of the Society at once.

AGARWALA, SUSHIL C.—Lecturer in engineering, Agricultural School, Chirgaon, (Dist Jhansi), U.P., India

BETZ, CARL H.—Designer, Round Table Foundation, Glen Cove, Me.

BRANDELL, JOHN R.—Sales engineer, Stewart Warner Corp., Chicago, Ill.

CLARK, MAURICE I.—Associate, Iowa Agricultural Experiment Station and assistant mgr., Ankeny Farm Service, Ankeny, Iowa

CLEMENTS, LLOYD W.—Supervisor, Bureau of Reclamation (USDI), Water Services Div., Field Investigations Unit, Los Banos, Calif.

CURRIN, SIDNEY T.—Assistant mgr and salesman, Williamston Tractor & Impl Co., Williamston, N. C.

DAESEN, JOHN R.—Executive engineer, The DoALL Co., Des Plaines, Ill.

DERBER, DONALD W.—Agricultural engineer, agricultural extension section, U.S. Steel Co., Pittsburgh, Pa.

DONOGHUE, LAWRENCE A.—Graduate assistant, agr. eng. dept., Ontario Agricultural College, Guelph, Ont., Canada

FORD, EARL M.—Designer, Eng. Lab., Ford Motor Co., Dearborn, Mich.

HARRISON, DALTON S.—Graduate fellow in agr. eng., Univ. of Florida, Gainesville, Fla.

HASLETT, GLENN M., JR.—Instructor in sales training, Caterpillar Tractor Co., Peoria, Ill.

IVERSON, ALVIN C.—Engineer, Scott Engineering Co., Watertown, S. Dak.

JOHNSON, LANGDON G.—Detail design draftsman, Harry Ferguson, Inc., Southfield Rd., Detroit, Mich.

KLINE, CHARLES M.—Trainee, New Holland Machine Co., New Holland, Pa.

LEQUEUX, HENRY D.—Regional service mgr., Harry Ferguson, Inc., Detroit, Mich.

MAMISAO, JESUS P.—Chief, div. of soil conservation operations, Dept. of Agriculture & Natural Resources, Manila, Philippines

MERTI, GLEN F.—Sales engineer, Stewart-Warner Corp., Chicago, Ill.

MILLIGAN, DAVID C.—Director of agricultural engineering services, Nova Scotia Dept. of Agriculture, Truro, N. S., Canada

MILNE, CHARLES M.—Junior assistant agricultural engineer, Purdue Agricultural Experiment Station, West Lafayette, Ind.

NIXON, PAUL R.—Agricultural engineer (SCS), USDA, Riverside, Calif.

PAUL, C. V.—Senior assistant, agr. eng. dept., Allahabad Agricultural Institute, Allahabad, U. P., India

PILL, ROBERT E.—Farmer, Cando, N. Dak.

PRINGLE, DONALD R.—Junior engineer, Vickers, Inc., Detroit, Mich.

RANK, CHARLES R.—Agricultural sales engineer, The Ohio Power Co., 6th St., Zanesville, Ohio

REEVE, R. C.—Chief engineer, wheel div., Joseph Sankey & Sons, Ltd., Wellington, Shropshire, England

ROHRER, DAVID A.—U.S. Army, R.R. 2, Junction City, Kans.

ROHWEDER, G. DEAN—Trainee, Caterpillar Tractor Co., Peoria, Ill.

RUNESTRAND, ROGER L.—Owner, Roseau Electric Service, Roseau, Minn.

(Continued on page 660)

How much winter can barnyard equipment take?

When it's made of Armco ZINCGRIP Steel, barnyard equipment will weather the worst of winter, year after year.

That's because Armco ZINCGRIP is so well protected against rust. Its special protective zinc coating adheres so tightly it doesn't peel or crack off when it's formed into stock tanks, poultry and livestock feeders and waterers, grain bins and other equipment.

That means there are *no unprotected places* where rust can start.

ZINCGRIP is only one of Armco's many Special-Purpose Steels used by manufacturers to give farmers better equipment. Another of these steels reflects heat better and lasts longer in heaters and crop dryers. Still another was developed especially to hold paint.

The Armco trademark on sheet metal parts of farm equipment is the farmer's assurance that the manufacturer has selected an Armco Special-Purpose Steel that is going to give longer, more trouble-free service.

ARMCO STEEL CORPORATION

MIDDLETOWN, OHIO, WITH PLANTS AND SALES OFFICES FROM COAST TO COAST
THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE

ARMCO

NEW BULLETINS

How to Teach Arc Welding in Farm Mechanics, by A. H. Hollenberg. James F. Lincoln Arc Welding Foundation (Cleveland 17, Ohio) (June, 1952). 25 cents per copy in U.S.A., 50 cents elsewhere. This 56-page booklet covers equipment requirements, shop plans, teaching suggestions and aids for high school teachers in farm mechanics. It is based on material and ideas contributed by more than 100 teachers and agricultural leaders representing all areas of the United States.

Planning Small Abattoirs for Georgia, by W. E. Garner and W. M. Bruce. Georgia Agricultural Experiment Station (Athens) Bulletin 1 (May, 1952). Of specific interest in terms of recommendations for improving farm and rural butchering equipment and practice, this bulletin is of further interest as an example of an engineering study dealing with many of the factors influencing the economy of rural processing. Suggestions and recommendations cover location, layout, cooling rooms, equipment, lighting, ventilation, sanitation, holding pens, offal rendering, utilities, operations, poultry processing, and meat smoking.

The Effect of Tractors on Volume Weight and Other Soil Properties, by E. R. Fountain, P. C. J. Payne, and J. C. Hawkins (May, 1952). National Institute of Agricultural Engineering (Wrest Park, Silso, Beds.) and Scottish Machinery Testing Station (Howden, Mid Calder, Midlothian) 4/, post free. Reports on exploratory and full-scale experiments, furrow-bottom experiments, and effects of spade-lug and track-type tractors. The authors conclude that volume-weight changes alone are not a satisfactory index to damage to soil by compaction, and that future work on tractor damage to soil structure might best be directed to effects on permeability to water and air.

Some Experiments with an Endless Band Threshing Mechanism, by G. R. Chambers et al (July, 1952). National Institute of Agricultural Engineering (Wrest Park, Silsoe, Beds., England). Reports on tests with a design in which an endless belt and extended concaves replace the conventional drum and concave arrangement and serve a combined threshing and separating function. The original object was to provide a machine adapted to easy cleaning for test plot work. Results are indicated to be favorable enough to suggest possibilities of using the design in commercially produced small combines for farm use.

Using Electricity in Watering Farm Gardens, by Earl L. Arnold. Farmers Bulletin No. 2044, U.S. Department of Agriculture, Washington 25, D.C. Introduces farmers to the main considerations involved in irrigation, especially on a small scale.

Mechanical Stonepickers, by H. F. McColly and F. W. Roth. Article 35-9, reprint from the Quarterly Bulletin, Vol. 35, No. 1, (Aug., 1952), Michigan Agricultural Experiment Station (East Lansing). Brief treatment of the economy of mechanical stone picking and the types of machines available.

A Recirculating Drier for Drying Pea Beans with Heated Air, by Carl W. Hall and Robert L. Maddex. Article 35-10, reprint from the Quarterly Bulletin, Vol. 35, No. 1 (Aug., 1952), Michigan Agricultural Experiment Station (East Lansing). A preliminary report which does not recommend the practice or equipment in its present stage of development, but suggests possibilities.

(Continued on page 662)

Applicants for Membership

(Continued from page 658)

SCHLUTER, CARL E.—Junior agricultural engineer, Central Power & Light Co., Corpus Christi, Tex.

SINCLAIR, JOE N., JR.—U.S. Army, Med. Co., 33rd Inf. Regt., Ft. Kobbe, Canal Zone

SMITH, WILLIAM H.—Agricultural sales engineer, The Ohio Power Co., Newark, Ohio

TANGEMAN, L. N.—Project engineer, Dempster Mill Mfg. Co., Beatrice, Nebr.

TULLOH, EDWARD L., JR. — Engineering assistant, Virginia Electric Power Co., Richmond, Va.

WALTER, TERRY L. — U.S. Air Force, RR, Tribune, Kans.

WEINERT, HARRY F.—U.S. Air Force, 3401 Student Sqd., Box 1351, Kessler AFB, Miss.

WESKAMP, HERMAN W.—Instructor, agr. engr. dept., Mt. San Antonio College, Pomona, Calif.

WILDER, CARL R.—Engineer, Portland Cement Assn., 518 Boston Bldg., Denver 2, Colo.

WOOD, WILLIAM S.—Engineer, The Boardman Co., Oklahoma City, Okla.

WRIGHT, EDWARD J. — Designer draftsman, Harry Ferguson, Ltd., Fletchamstead Highway Coventry, Warwickshire, England.

TRANSFER OF MEMBERSHIP GRADE

BAKER, VERNON H.—Graduate student in agr. eng., Michigan State College, East Lansing, Mich. (Associate Member to Member)

HALL, CARL W.—Assistant professor of agr. eng., Michigan State College, East Lansing, Mich. (Associate Member to Member)

JESSOP, RONALD B.—Land reclamation and cultivation expert, FAO, Rome, Italy (Affiliate to Member)

The world-famous FERGUSON SYSTEM with *Exclusive* SSC* SUCTION-SIDE CONTROL will be found only in the Far More Powerful FERGUSON "30"!

BIGGER

- ★ in power
- ★ in performance
- ★ in economy

*If you want the most complete, the most perfect hydraulic *control* system ever built into a tractor, you'll find it *only* in the Ferguson "30".

There can be nothing else like it . . . *anywhere* . . . for *only Ferguson* can have a hydraulic control system with the vitally important *Suction Side Control!*

You must see this control system *demonstrated* before you can truly believe the remarkable things it can do. For example . . .

Where ordinary hydraulic systems merely raise and lower implements, the Ferguson System, with *Suction Side Control,* raises, lowers and *controls* ground-engaging implements in direct relation to *draft!*

Ask your Ferguson Dealer for a "Showdown" demonstration right on your own farm. He will gladly prove to you the advantages of the famous Ferguson System with *Suction Side Control!*

This Booklet Tells the Story

Ask your Ferguson Dealer for your free copy of "The Inside Story of the Ferguson System with Exclusive Suction Side Control." It tells you things about tractor control that you may never have known before.
Harry Ferguson, Inc., Detroit 32, Mich.

FERGUSON TRACTOR

and 63 Ferguson System Implements

NEW BULLETINS

(Continued from page 660)

Use of Corn Cobs as a Filler for Concrete Used in Farm Construction, by J. S. Boyd and T. J. Brevik. Article 35-11, reprint from the Quarterly Bulletin, Vol. 35, No. 1 (Aug., 1952), Michigan Agricultural Experiment Station (East Lansing). Reports characteristics satisfactory for some uses, from several mixes including significant amounts of ground cobs.

A Small Lumber Drying Unit Employing a Portable Crop Drier for Heat and Air Circulation, by Kenneth E. Kimball and O. W. Torgeson. Report No. R 1799 (June, 1952), Forest Products Laboratory (Madison, Wis.), Forest Service, U.S. Department of Agriculture. Adaptation of a recirculating portable farm crop drier to the drying of lumber for a farm woodlot scale of sawmill operation is reported to show promising results in economy and quality of drying.

Fruit Grading Machinery — A Survey, by R. J. Courshee and L. R. Hoare (July, 1952). National Institute of Agricultural Engineering (Wrest Park, Silsoe, Beds., England). Each part 5 s, post free. This survey is published in three parts. Part 1 presents the testing technique and summarized results. Parts 2 and 3 are appendices presenting in considerable detail information on tests of individual graders. The report covers 14 different graders.

Maintaining the Farm Wiring and Lighting System. Southern Association of Agricultural Engineering and Vocational Agriculture (coordinator's office, agricultural engineering department, University of Georgia, Athens) (June, 1952). This is another in a series of booklet aids for teaching in vocational agriculture. It presents in brief text and numerous illustrations the sound electrical trade practices for maintaining cords, plugs, sockets, switches and outlets, which should be common knowledge on every electrified farm.

Electric Radiant House Heating. Technical Standards Division, Rural Electrification Administration, U.S. Department of Agriculture (Washington 25, D.C.) (Revised July, 1952). This is an exceptionally well written and concise summary of information on house heating principles, types of electric radiant heating systems for homes, cost of heating with different fuels, design factors, and a partial list of manufacturers of electric radiant heating equipment. Cost is indicated as generally comparable to that for heating with coal, oil, and gas where adequate electricity is available at one half cent per kilowatt hour.

Grassland Farming Program

THE Joint Committee on Grassland Farming will hold its 1952 annual meeting on Thursday, December 18, at the Edgewater Beach Hotel in Chicago, Ill., following and in conjunction with the Winter Meeting of the American Society of Agricultural Engineers. Requests for full information concerning this meeting should be addressed direct to the secretary of the Joint Committee, Z. W. Craine, P.O. Box 30, Norwich, N. Y. The program for the meeting follows.

Forenoon Program

Presiding: *Paul D. Sanders*, editor, *Southern Planter*

9:00-9:20 Organization

9:20-9:50 The Birth of Grasslands in the South—*Paul W. Chapman*, associate dean of agriculture, University of Georgia

9:50-10:00 Discussion

10:00-10:30 The Banker's Stake—*Fred O'Hair*, director, dealer-district program, National Retail Farm Equipment Assn.

10:30-10:40 Discussion

10:40-11:10 Farm Replanning for More Profit — *William M. Myers*, chief, division of agronomy and plant genetics, University of Minnesota

11:10-11:20 Discussion

11:20-11:50 Pasture Management for Intensive Grazing — *Robert Hogarth*, manager, Butterfly Farms (New York)

11:50-12:00 Discussion

Afternoon Program

Presiding: *Thomas E. Milliman* (Co-operative Grange League Federation Exchange, Inc.), chairman, Research Committee, Joint Committee on Grassland Farming

1:30-2:00 What the Neighbors Are Doing — *John Strohm*, associate editor, *Country Gentleman*

2:00-2:10 Discussion

2:10-2:40 Grassland Mechanization, 1960 — *L. H. Hodges*, J. I. Case Co.

2:40-2:50 Discussion

2:50-3:20 Stop Worrying About Eating — *Firman E. Bear*, chairman, soils department, Rutgers University

3:20-3:30 Discussion

3:30-4:00 What Have We Learned Today? (A Summary) — *Paul D. Sanders*

NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

Nickel Alloy Gear Literature

Modern Trends in Gear Materials: Part I, Nickel Steel and Cast Iron (20 pages); Part II, Two New Gear Materials (11 pages) is a new illustrated technical guide (23 tables and 70 charts) published by the International Nickel Co., 67 Wall St., New York 5, N. Y., for the purchaser of replacement gears, and for design and production engineers concerned with mechanical properties, ease of fabrication and economy. Carburizing and direct hardening nickel-alloy steels and low and medium silicon nickel gray cast irons are covered. Machinability and the effects of various types of heat-treatment are discussed. Characteristics of a precipitation hardening nickel steel, Nitralloy N, are reviewed. Recently developed ductile iron is evaluated as offering a new material that combines many of the advantages of steel and gray iron.

Lubrication Booklet

The Fafnir Bearing Co., New Britain, Conn., recently issued a new folder, entitled "The Lubrication of Fafnir Ball Bearings." In eight pages of text and illustrations it gives in non-technical language the why and how of matching lubricants and lubrication practice to bearing types and service conditions. Copies are available on request to the company, its branches, or authorized distributors.

New Plow Catalog

A new edition of the plow catalog issued by the Massey-Harris Co., Racine, Wis., is ready for distribution. Printed in color, the 24-page booklet describes and illustrates the company's complete line of moldboard and disk plows. The first section deals with the 28 and 27 moldboard plows featuring the Massey-Harris constant-clearance lift, adjustable wheel bearings, and remote hydraulic control.

Following parts are devoted to the 35 mounted plow with X-braced construction, the 41 two-way mounted plow with equalized weight distribution, and the 40 mounted plow with adjustable clevis hitch. Also featured in the new catalog are the 33 roll-over plow, the 2 and 3-furrow mounted disk plows, and the 400, 500 and 600 series disk plows.

Free copies of this catalog are now available and will be furnished by the manufacturer on request.

Building Farm Implements in India

TO THE EDITOR:

AS MANY members of the American Society of Agricultural Engineers have indicated interest in the development of our work in agricultural engineering at the Allahabad Agricultural Institute, they will be interested to know that I have just had word that the initial contribution has been secured to make possible the starting of an implement factory for which I have been working for some twelve years or more. We have designed certain implements which seem to us to fit the needs of the cultivators very well, and, for lack of any better arrangement, have been manufacturing them in the Institute workshop, which is primarily a maintenance workshop. With no real sales organization, we have sold about 1000 implements a year and feel that the market can be definitely expanded with better manufacturing facilities and a real sales organization.

We have set up a sort of trust society to be known as the Agricultural Development Society which will take over the manufacture and distribution of all implements developed in the agricultural engineering department of the Institute. We hope to be able to proceed with this scheme by next spring some time. So far only a part of the capital needed for the scheme has been provided and we still need more capital even for minimum operations.

MASON VAUGH

Head, Agricultural Engineering Dept.
Allahabad Agricultural Institute
Allahabad, India

NEW BULLETINS

Estimates of Irrigation Water Requirements for Crops in North Dakota, by Sterling Davis, Norman A. Evans and Arlon G. Hazen. North Dakota Agricultural Experiment Station (Fargo) Bulletin No. 377 (May, 1952). Reports work in cooperation with the Soil Conservation Service, U.S. Department of Agriculture, dealing largely with consumptive water requirements and irrigation water requirements in the area.

The Development of a Universal Vegetable Washing Machine of Medium Output, by Graham Bean and E. R. Hoare (July, 1952). National Institute of Agricultural Engineering (Wrest Park, Silsoe, Beds., England). Covers current practices, desirable features, special features, mechanical design, and performance of a horizontal circular conveyor type machine.

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—APRIL—O-603-568. MAY—O-619-570, 630-572. JUNE—O-657-573, JULY—O-712-575. AUGUST—O-733-577, 736-578. SEPTEMBER—O-740-580, 741-581.

POSITIONS WANTED—APRIL—W-592-109. MAY—604-113. JUNE—W-674-120, 678-121, 661-122. JULY—W-694-123, 691-124, 682-125, 700-126, 704-127. AUGUST—W-692-128, 721-129, 722-130, 693-131. SEPTEMBER—W-735-133, 739-134.

NEW POSITIONS OPEN

DESIGNERS, various grades, for work on modern farm tractors and implements with a large manufacturer in the Midwest. BS deg in agricultural engineering, or equivalent. Must be congenial and able to work with others. Recent graduates considered if genuinely interested in design. Higher positions according to extent of successful experience in design of modern farm equipment or similar items. Excellent opportunity for advancement. Salary open. O-767-583

SUPERVISOR, expert service for service program and training courses in Central and South America, with farm tractor and equipment manufacturer in the Midwest. Must have supervisory ability and be able to read, write and speak Spanish fluently. Agricultural engineering background preferred. Above average intelligence and ability to get along well with others. Excellent opportunity for advancement. Time divided approximately equally between work at company headquarters in Midwest and travel in Central and South America. Age 30-40. Salary open. O-767-584

TEACHER of farm mechanics and rural electrification in department of agricultural engineering in a land-grant university in the Southwest. Full-time teaching of service courses on 9 mo basis. BS deg in agricultural engineering. MS deg preferable. Special training in fields of instruction, teaching experience in these fields, or practical work in these fields in industry. Good recommendations as to training, experience, and temperament. Salary open. O-770-585

AGRICULTURAL ENGINEER for teaching and research in farm structures in a land-grant university in the Southwest. BS and MS deg in agricultural engineering, or equivalent, with major in farm structures. Research and practical experience desirable. Good recommendations as to character, training, experience, and temperament. Excellent opportunity for advancement to head farm structures work in the department. Salary open. O-770-586

SALES ENGINEER to make field contacts with fabricators of aluminum building products, maintain liaison with college extension service and engineering departments, assist in design and preparation of farm building plans, with a large producer of aluminum structural materials. Location Midwest. BS deg in agricultural engineering or equivalent, with training in farm building design and in irrigation. Experience in these fields desirable. Must be able to meet and talk with sales organizations, engineers, and university people; have impressionable manner in making sales engineering contacts. Good opportunity for advancement with technical department of a large primary aluminum producer. Age 25-35. Salary open. O-759-587

COORDINATOR for statewide electric power use program, REA. Work requires supervising and coordinating local level educational programs of more than 50 REA cooperatives in one midwestern state. BS deg in agricultural engineering, or equivalent. Extension, teaching, or commercial experience in rural electrification desirable. Good personality, integrity, sobriety, and initiative. Salary open. O-760-588

DESIGN ENGINEERS and draftsmen for engineering department work with fast-growing, progressive major farm equipment manufacturer located in Southeastern Wisconsin. Immediate openings. Degree desirable but not required. Opportunities are unlimited! Salary open. Submit qualifications in detail. O-782-589

AGRICULTURAL ENGINEER (GS-9) for instruction, extension and research work in farm structures and machinery fields, in Alaska. BS deg in agricultural or mechanical engineering. Civil Service requirements. Prefer farm background. Salary $6325, including cost of living differential. O-783-590

DESIGNER, agricultural or mechanical engineer, for improvement and new design work with farm equipment manufacturer in the East. College degree and at least two years experience. Must be neat, efficient and adaptable. Opportunity commensurate with ability. Salary open. O-785-591

PRODUCT DESIGN ENGINEER and assistant to chief engineer, for work on mowers, rakes, choppers and related equipment, with manufacturer in the Midwest. BS deg in agricultural or mechanical engineering desirable, but not essential for a man with a good background of experience in product design. Experience 5 to 10 yr in engineering product design, preferably in farm machinery and drafting room practice. American citizen, good health, sober, and industrious. Excellent opportunity for qualified man. Age 30-40. Salary open. O-758-592

(Continued on page 668)

Ask for G-E Motors and Control on all Electrified Farm Equipment you buy!

GENERAL ELECTRIC

FarmNews

Ask for G-E Motors and Control on all Electrified Farm Equipment you buy!

MORE POWER TO THE AMERICAN FARMER through more electricity on the farm

FARMER ELIMINATES A BACK-BREAKING JOB!

One man loads 380 bushels of ear corn per hour with lightweight portable elevator; cuts labor costs

"One of the hardest farm jobs today," says Mr. Lloyd Reiterman of Kingston, Ohio, "is moving bulk materials such as litter, feed or crops from one spot to another. And today it's just about impossible to get people to do that kind of work—at least, not economically."

Licks manpower problem

"But," continues Mr. Reiterman, "I've licked that problem with this lightweight elevator. Just one man can put it wherever it's needed and move crops in and out of bins, cribs and trucks."

Moves 100,000 bushels

"I've used this elevator since 1950. It's handled at least 100,000 bushels of corn and about 5,000 bushels of wheat during that time—and it has really taken a beating!"

"But I've never had any trouble with it, and I've cut my labor costs to a minimum. Not only that, but my truckman thinks the elevator is great. He says it's a back-saver. Besides getting many times more work done than he could with a scoop-shovel, he doesn't have to work so hard."

Handles many materials

This elevator will handle practically anything that needs to be moved in bulk on the farm.

The one Mr. Reiterman has will move up to 250 bushels of wheat or soybeans per hour, 275 bushels of shelled corn, 680

One man moves 380 bushels of ear corn per hour with lightweight portable elevator.

bushels of oats—at a 35-degree angle. It has paid for itself long ago in labor costs alone.

Uses newly-developed motor

Powered by its **extra**-lightweight G-E motor (a recent G-E development) and made of aircraft-quality aluminum, the elevator weighs just over 100 pounds. A lighter-weight model, as well as various lengths and modifications are also available. For more information check "Portable Elevator" in coupon.

"MANY TOOLS IN ONE" DOES THIS FARMER'S SHOP WORK

When the company that makes this remarkable machine says "it can build and furnish a house," they have the full, enthusiastic agreement of Mr. William L. Pettit who owns a 400-acre farm in Davis, California.

Mr. Pettit has made all kinds of useful and ornamental articles, from gears and pulleys to lawn decorations.

Complete workshop in one tool

In this one machine, run by a ½-HP lightweight G-E motor, Mr. Pettit has a complete workshop of five basic tools: saw, drill press, lathe, disc sander, horizontal drill—all combined in a precision-engineered, husky, compact unit.

No wonder he, like hundreds of other farmers, thinks it's great! For more information check "Combination Workshop" in coupon.

SOLVES COLD-WEATHER PROBLEMS WITH MOTORIZED HEATER

In cold Houghton, N. Y., Mr. Arthur D. Williams protects his milking parlor from freezing and dampness with two 1500-watt electric milk house heaters.

He also gets comfortable heat at milking time, and the old problem of winter milk house comfort is solved. As Mr. Williams points out, these heaters are necessary when you have a milking parlor—pen stabling set up.

Mr. Williams says these heaters have been in operation for three years and have never failed or given trouble. With their thermostatic control, he sets one temperature for working, another for economical protection against freezing.

A G-E unit bearing motor and G-E Calrod* heater are basic components of this heater. For more information check "Electric Heater" on the coupon.

Electric milk house heater supplies comfortable heat during milking time at Mr. Williams' farm. Safety features permit use of heater even where hay is present.

*Registered Trademark of General Electric Co.

General Electric Company
Section 671-23D, Schenectady 5, N. Y.
I would like additional information on the following equipment.

- ☐ Portable Elevator
- ☐ Electric Heater
- ☐ Combination Workshop
- ☐ "How to Choose Your Motor"

NAME ____________

ADDRESS ____________

CITY ____________ STATE ____________

PROFESSIONAL DIRECTORY

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to ASAE members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

Personnel Service Bulletin

(Continued from page 666)

TERRITORY REPRESENTATIVE (2 openings) for wholesale distributor of farm equipment, to call on retail implement dealers in territory of 12 to 15 counties. Territory open in central Pennsylvania and in southern Ohio. BS deg in agricultural engineering, or equivalent, desirable. Agricultural background and preferably some wholesale selling experience. Must have no physical defects, be aggressive, and willing to be away from home two or three nights a week. Salary and commission provide pay proportional to effective work. Age 27-45. Salary $6,000-$10,000. O-778-593

WORKS MANAGER combining factory and production manager duties in coordination, purchasing, production planning and control, inventory control, methods, cost processing, and engineering. With farm equipment manufacturer in California. BS deg in mechanical or industrial engineering desirable but not essential. Prefer man with harvester and tractor manufacturing experience, executive and administrative ability to coordinate production and engineering, good personality, ability to work with others, married, with family. Growing company with expanding volume. This is a top management position in the organization but might lead to a position of higher responsibility. Age 40-50. Salary $9,000-$10,000 and possible bonus. O-786-594

ASSISTANT PROFESSOR in agricultural engineering for research design and development of materials handling equipment for forage and grain crops, in a land grant university in an east central state. BS and MS deg in agricultural engineering with major in power and machinery. Livestock farm background and some machine design experience desirable. Ability to work cooperatively with others. Initiative and imagination for creative work. Good opportunity for advancement on merit. Excellent retirement program. One month vacation. Salary $4,850. O-744-595

NEW POSITIONS WANTED

DESIGN, development, research or teaching in farm structures or soil and water field, preferably in South or Southwest. BS deg in agricultural engineering, Texas A. & M. College. Graduate study in economics. Agricultural and civil engineering experience with SCS 10½ yr., including reinforced concrete and hydraulic design, flood control surveys, irrigation, drainage, and related work. War and postwar noncommissioned service in infantry, military police, and ordnance, 2 yr. Married. Age 34. Ten per cent disability due to scoliosis. Available on reasonable notice. Salary open. W-727-135

DEVELOPMENT, sales, or service in farm structures field, anywhere in U.S.A. BS deg in agriculture, major in agricultural engineering, 1947, University of Florida. Graduate study at University of Tennessee. Farm background. Experience teaching farm structures and shop, 3 yr. Appraiser-engineer with FHA, 2 yr. War commissioned service as pilot in Naval Air Corps. Married. Age 32. No disability. Available on 30-day notice. Salary open. W-762-136

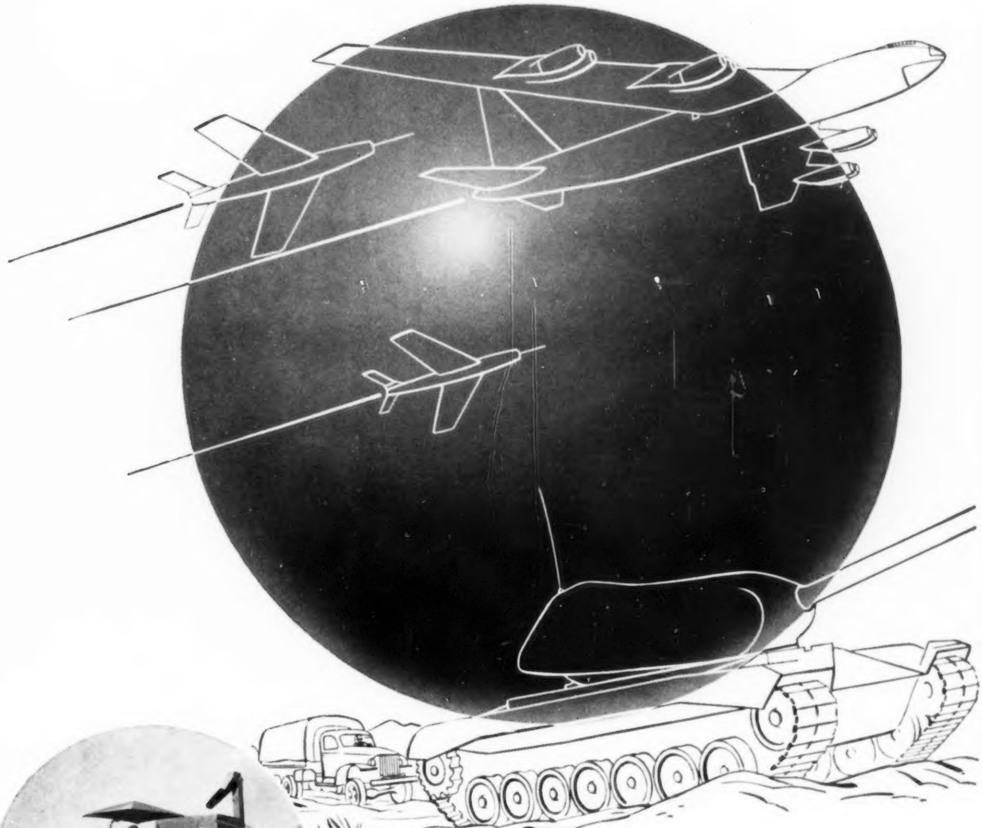
DESIGN, development, or research in power and machinery or soil and water field, anywhere in U.S.A. BS deg in agriculture, 1950, University of Maine. Farm background with experience in farm operation and repair and maintenance of farm equipment. Enlisted and noncommissioned service in Army since October, 1950, with promotions to Master Sergeant. Married. Age 25. No disability. Available about Nov. 8. Salary open. W-769-137

SALES PROMOTION or product development in farm structures or rural electric field, in industry, anywhere in U.S.A. BS deg in agricultural engineering 1947. Farm representative for electric utility in an eastern general farming area 1½ yr. Extension agricultural engineer in an eastern state 3 yr. War service in Air Corps 4 yr. Currently on recall tour as Captain U.S.A.F., four-engine instructor pilot. Release due in December. Married. Age 31. No disability. Available Jan. 1. Salary open. W-765-138

EXTENSION, service, or writing in power and machinery, farm structures or soil and water field with manufacturer or trade association preferably in North Central area. BS deg in agricultural engineering, 1941, South Dakota State College. Experience 2 yr as agricultural engineering specialist in Soil Conservation Service; 2½ yr as civil engineer on rivers and harbors work and war construction with U.S. Army Corps of Engineers; 6½ yr as extension agricultural engineer in a midwestern state. Married. Age 38. No disability. Available Jan. 1. Salary open. W-775-139

EXTENSION, teaching, research, sales, service, or writing, in power and machinery or soil and water field, in industry or public service, anywhere in the USA. Will consider foreign location where family may accompany. BS deg in agricultural engineering, 1949, Iowa State College. MS deg in agricultural engineering, expected December, 1952, Michigan State College. Iowa farm background. One summer as student engineer with farm equipment manufacturer. Instructor in soil and water, farm mechanics, and power and machinery, while working for MS deg. War enlisted service, 20 months, mostly as superintendent of map library at Army Command and Staff College, Fort Leavenworth, Kans. Married. Age 28. Nearsighted, corrected by glasses. Available January 1. Salary $5500 min. W-784-140

SILENT SOLDIER FOR DEFENSE!



Factory, Farm and Fighting Front...

- On the Korean front, on farms deep in the heart of America, in factories geared to the needs of defense . . . New Departure Ball Bearings are worthy warriors.
- From seed time to harvest, New Departures help increase production on the farm front. Implements operate at higher speeds, with greater efficiency and less maintenance, because of them. Many new agricultural applications feature Sealed-for-Life ball bearings originated by New Departure.
- The Great Ball of New Departure is the symbol of engineering excellence. A staff of application engineers stands ready to aid designers or builders of farm equipment. Keep your eye on the BALL to be sure of your BEARINGS!

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT